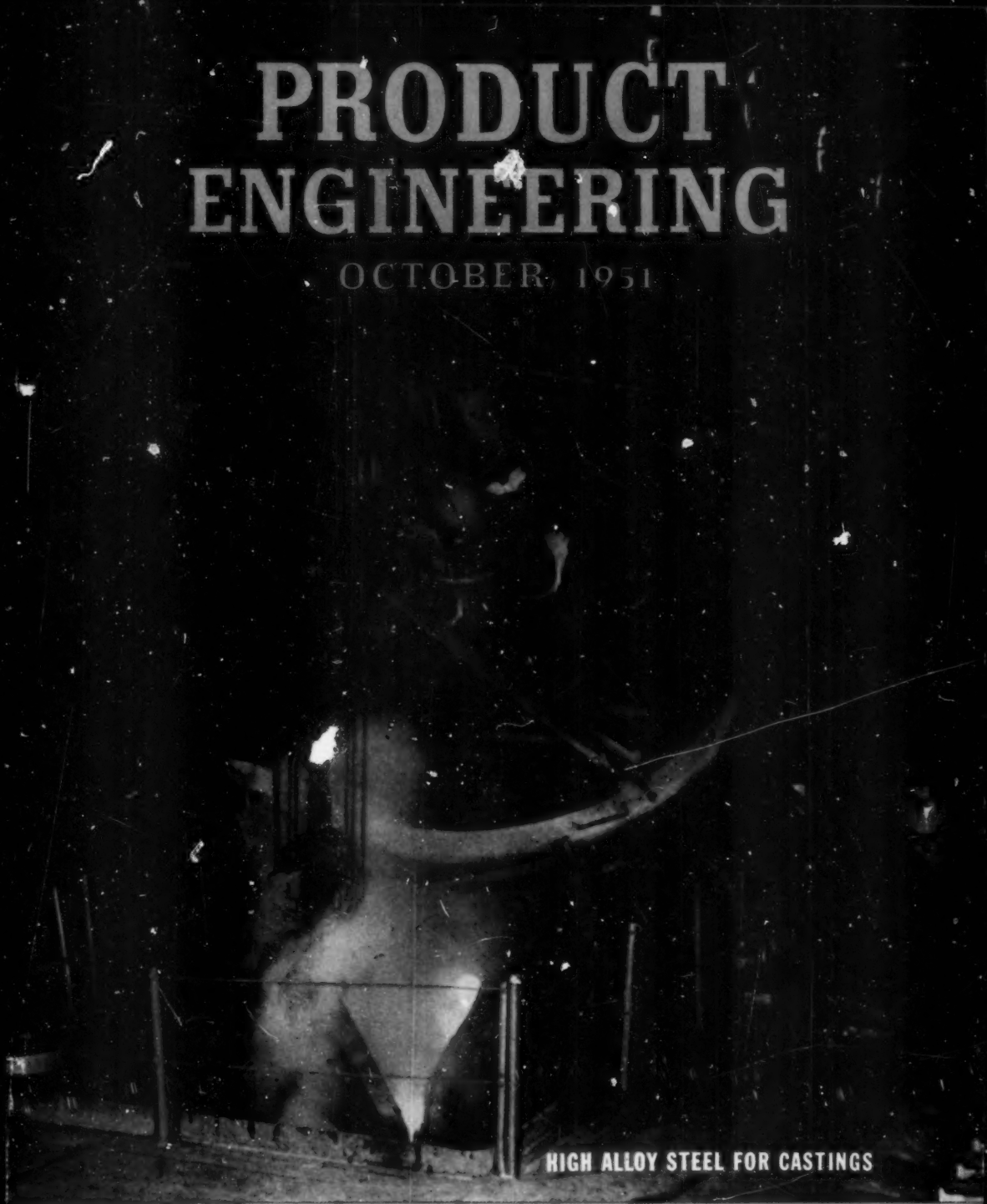
PRODUCT ENGINEERING

OCTOBER 1951



HIGH ALLOY STEEL FOR CASTINGS

IN THIS ISSUE—How to Tackle Materials Substitution • Automatic Card Memory Device • Tube Rectifier Circuits • High Speed Governors • Aluminum Finishes

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FIVE DOLLARS A YEAR

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Speed is the essence of modern warfare. Whole armies must move fast—even over scorched earth. Retreating units must combat this speed—slow down the pursuer. A most effective method is the destruction of bridges. Rivers are natural barriers to a mechanized fighting force.

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Engineers are able to span an impassable ravine in a matter of minutes with a structure that can support loads up to 70 tons. This makes the Bailey Bridge a vital instrument of warfare—one that requires tons of steel. Sharon Steel Corporation is a supplier of steel for these bridges.

*Specialists in STAINLESS, ALLOY, COLD ROLLED and COATED Strip Steels.

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Sharon, Pennsylvania

DISTRICT SALES OFFICES: CHICAGO, ILL., CINCINNATI, O., CLEVELAND, O., DAYTON, O., DETROIT, MICH., INDIANAPOLIS, IND., MILWAUKEE, WIS., NEW YORK, N. Y., PHILADELPHIA, PENNA., ROCHESTER, N. Y., LOS ANGELES, CALIF., SAN FRANCISCO, CALIF., MONTREAL, QUE., TORONTO, ONT.

For information on Titanium Developments contact Mallory-Sharon Titanium Corp., Indianapolis 6

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with Ross Full-Flo In-Line Valve you get Full Pipe Capacity!

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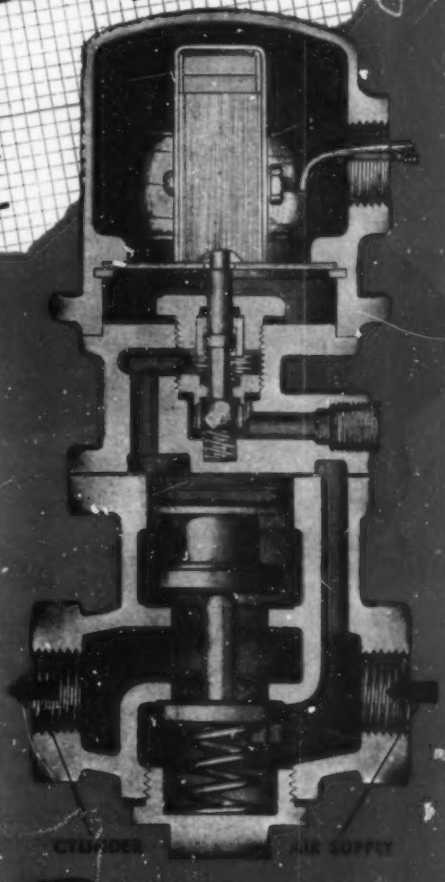

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REVERE COPPER AND BRASS INCORPORATED

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VOLUME 22

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NUMBER 10

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How to Tackle Materials Substitution 123
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It's a BIGGER Red Feather This Year!

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ABP ABC

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Elkonite* Contacts *Offer Cost-Saving Versatility*

Many Mallory customers have been helped to better contact performance at lower cost by Mallory engineering.

A joint investigation between Mallory and a manufacturer of industrial circuit breakers revealed that, because of an improvement in the breaker, the standard Mallory Elkonite being used for an arcing tip had a higher AR** factor than required. Mallory took the initiative and developed a new grade of Elkonite that more than met the service requirements . . . and at a substantially lower cost.

That's value beyond expectation!

This incident is another demonstration of Mallory initiative and the versatility of Elkonite by which a variety of performance and cost ratios can be secured by combining the properties of the constituent metals to precisely the right degree.

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you.

In Canada, made and sold by Johnson Matthey & Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

ELKONITE CONTACTS

Elkonite is the registered trade mark for a series of contact materials developed by Mallory and manufactured from metal powders. They are best known for their hardness, resistance to mechanical wear and impact, resistance to erosion by arcing (AR factor), and resistance to sticking.

Elkonite contacts are made by a unique and time-proved method which permits the combining of the desirable features of basic metals which cannot be alloyed. By this means, the high melting points of tungsten, molybdenum, or their carbides, can be combined with the current-carrying ability of silver and copper.

*Reg. U. S. Pat. Off.
**The ability of a contact material to withstand the erosion of an electric arc.

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Welding Materials

Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear.

NONMETALLIC MATERIALS

POLYVINYL ELECTRICAL TUBING made by Extruders, Inc. of Hawthorne, California, meets all the requirements of the USAF Specification 12047-A. In addition to high dielectric strength, low temperature stability, and corrosion resistance, specification calls for resistance to fungus.

TAILORED FOR SPECIAL USES, four new synthetic rubber latices have been announced by Goodyear's Chemical Division. These Chemigum materials are aqueous dispersions of butadiene-acryl copolymers and are intended for coating applications requiring resistance to oils and solvents.

ONE PART SILICONE OIL and seven parts carbonyl, presumably iron, are a satisfactory magnetic fluid for use in a dynamometer control. This mixture has low residual torque and high magnetic fluid torque, according to tests conducted at the University of California.

DRY ICE is serving the rubber industry by removing fins from molded rubber parts. Placed together in a tumbling barrel, the ice freezes the projections and makes them brittle. In that condition, they break off as the drum rotates.

"STAMP INK" is both non-corrosive and non-etching, yet it adheres permanently to all metals, especially aluminum, magnesium and stainless steel. Marketed by Organic Products, Irving, Texas, ink air-dries to an abrasion-resistant film of a desired color. Markings appear on a dark surface when aluminum powder is sprinkled on the ink pad.

A VAPOR OF FLUOROCARBONS, instead of oil, cools and insulates a transformer that's being developed by Westinghouse engineers. The transformer is one-third lighter, can dissipate ten times more heat under overload conditions, and delivers 3.5 times as much power as can an oil-cooled transformer of comparable size.

FOAM CORE MATERIAL has compressive strength of 500 psi, making it useful in structural applications. Called Cor Foam, the phenolic resin "sets" at room temperatures into a hard, non-connecting cellular honeycomb. Rezolin, Inc., Los Angeles, says it adheres to wood and plastics.

AIRPLANE PROPELLER BLADES are now being filled with "hard" sponge rubber that reduces vibration, twisting and damage from impact. Hamilton Standard compounds this HS-160 material from Hycar rubber, a phenolic and nylon.

METALLIC MATERIALS

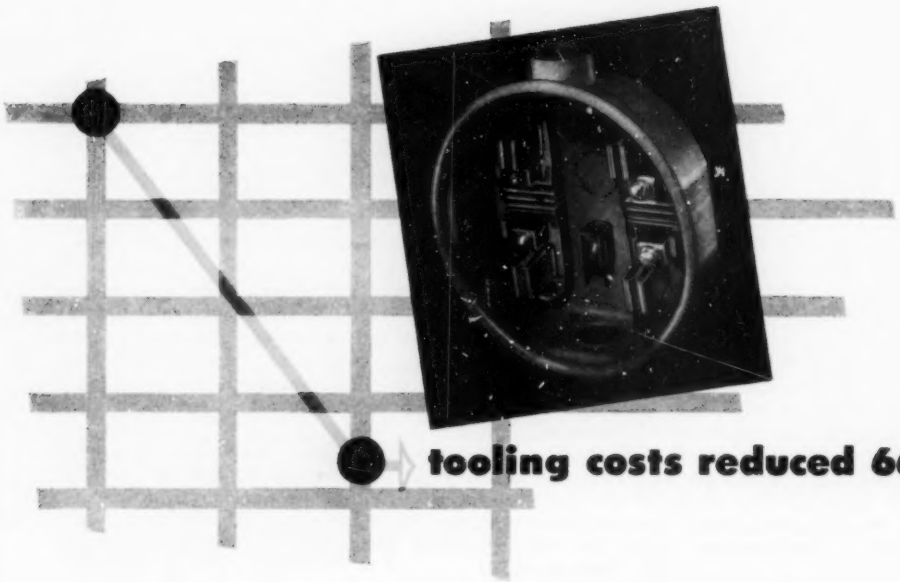
SURFACE TEARS that occasionally lead to creep failures in aluminum alloy castings subjected to elevated temperatures rarely if ever occur in a new ML alloy developed at Wright-Patterson Air Force Base. New composition has yield strength of 27,400 psi and elongation of 1.5 percent in 2 in. at 400 F; while at 600 F, comparable figures are 14,500 psi and 9.0 percent, respectively.

ALUMINUM BRONZE ALLOYS are susceptible to stress corrosion, which is sometimes caused by moisture and ammonia in the atmosphere. Sam Tour Inc., Consultants, New York City, reports the failure of an aluminum bronze ring which abutted a nylon gear in a water system. The reaction of nylon and water to produce ammonia is believed to be the cause of failure.

THE UNDERWRITERS' LABORATORIES now approve the use of magnesium and magnesium alloys as safe materials for use in the housings of portable electrical appliances. Under ordinary conditions, the alloy must be at least 0.080 in. thick, and as such, there is little danger of fire from the use of these materials.

GRADE-C PHOSPHOR-BRONZE clad to each side of a copper strip in various ratios of thickness for each layer forms a combination useful in spring applications. Where percentage thick-

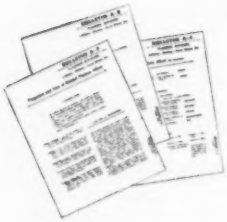
(continued on page 7)



tooling costs reduced 66⅔%

Let Mr. Ray Blakeman, president of Blakeman Bros. Electric Mfg. Co., Los Angeles, tell you this story of savings with Plaskon Alkyd Molding Compound in the manufacture of his company's commercial and residential watt-hour meter-mounting devices. Mr. Blakeman writes: "Tooling cost is about one-third using this material as compared to the tooling cost of other plastic materials"..."We have found that Plaskon Alkyd lends itself very well to automatic molding, giving us a high production rate on automatic presses"..."Percentage of reworks and breakages is extremely low"..."Our particular device requires a high dielectric strength for which Plaskon Alkyd is noted"..."Since using Alkyd we have not had one operating failure...of our product."

Here is more evidence that parts can be molded better and faster at lower cost—with the amazing quick-curing plastic which has created new concepts of speed and economy in compression molding.



It may pay you well to check the possibilities of Plaskon Alkyd in relation to your product. We will be glad to send you a complete set of the latest bulletins describing the many unusual properties of this unusual thermosetting plastic molding compound.

mold it better and faster with

PLASKON DIVISION • LIBBEY-OWENS-FORD GLASS COMPANY
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Manufacturers of Molding Compounds, Resin Glues, Coating Resins

PLASKON
ALKYD

nesses are 20-60-20- resistivity is 17.0 ohms per circular-mil-foot for a conductivity of 60 percent; with 35-30-35 laminations, resistivity is 27.7 and conductivity 38 percent.

SUBSTITUTE for laminated steel cores is P. R. Mallory's Himag, a non-critical iron material.

Pressed parts, such as television deflection coils for high frequency range, have electrical properties intermediate to those for rolled and stacked laminations and conventional iron cores.

PROCESSES

CONTINUOUS-ARC MELTING of titanium sponge in an automatic furnace permits the continuous casting of a cylindrical ingot in an inert-gas atmosphere. By using extremely dense grades of graphite electrodes, duPont limits contamination to 0.2 percent. Physical properties of arc-melted titanium are intermediate between those of high purity titanium made by the iodide process and induction-melted metal.

SPRAY PAINTING TECHNIQUE uses of principle electro-static atomization. Paint is pumped at a

metered rate to a cone-shaped head rotating at high speed. High potential electro-static field between head and workpiece pulls very fine charged paint particles to the work. Ransburg Electro-Coating Corp. of Indianapolis is responsible for the development of this technique.

SUPER-FINE STEEL TAPE 0.0005 in. thick and 8.5 in. wide can be rolled on a new cold-roll mill at the Naval Ordnance Laboratory, White Oaks, Md. Mill takes strips 0.025 in. thick and rolls them through an oil-filled chamber. Uses of tape: pulse transformers, magnetic amplifiers and guided missiles.

WHITE BRASS PLATING is gaining favor as a substitute for nickel on automotive hardware. Solution is basically cyanide with additives. Anodes are 80 percent zinc and 20 percent copper. A flash of chromium completes the job. Developed by duPont, the mirror-like plating is 0.0003 to 0.0004 in. thick.

IF OVERSEAS SUPPLIES of bauxite are curtailed, "local" kalunite alumina can be reduced to aluminum of commercial value. Refinement costs are high but half of product is 99.6 percent aluminum.

ELECTRO-MECHANICAL METHOD of machining permits cutting any electrically conductive material, regardless of hardness. Method X Co. of Philadelphia, an affiliate of Firth Sterling Steel & Carbide Corp., uses a controlled electric spark which sets up stresses in a workpiece, causing particles to fly off without being melted. Machining tolerances as low as 0.0005 in. can be maintained consistently.

FLAME POLISHING cuts time to grind and finish plastics that have rough edges. An oxidizing oxyhydrogen flame from a blow pipe is passed

over the edges to be polished. Two passes at speed of 10 to 20 ft per min are required for sawed edges. Particularly rough edges require preliminary sanding with a 150-grit abrasive paper.

TO CAPITALIZE on the high temperature properties and abundance of molybdenum, considerable time is being spent on processes for preventing oxidation. One method is cladding with nickel or an alloy of 90 percent platinum and 10 percent rhodium. Cost is a problem here. Another technique is the vapor deposition of silicon, a development of Fansteel Metallurgical Corporation.

COMPONENTS

BAND CLAMP for mounting cylindrical instruments in a panel permits removal from dial side instead of from behind. As a screw in the panel face is turned, a cam in the split band assembly relaxes tension in the band, permitting instrument to be pulled through panel. Marman Products, Inglewood, California are the makers.

REMOTE READING INDICATOR consists of a rotating card that exhibits one of three printed

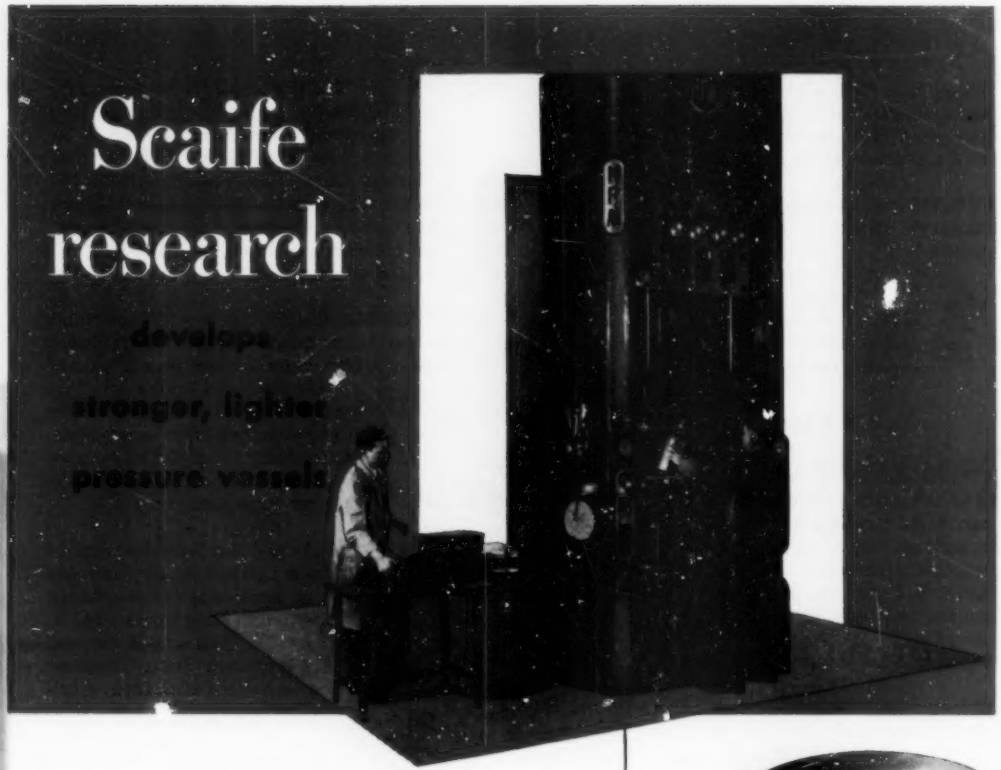
symbols at a window on the instrument. Card is rotated by two solenoids which draw it up or down to either of two extreme positions. When neither coil is energized, spring-balanced cylindrical card returns to neutral position. Riverside Metal Co., Riverside, New Jersey.

MEDIUM-SPEED COUNTING, amplifying and control applications are intended uses for a ferro-resonant flip-flop made by Computor Research Corp. of Torrance, Calif. Compared to a vacuum tube of comparable capacity, device has no filament, fills a tenth the amount of space, con-

(continued on page 9)

Scaife research

develops stronger, lighter pressure vessels



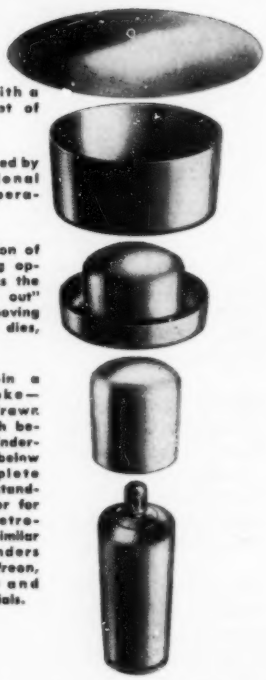
The pressure vessels and deep-drawn shapes being made today in the Scaife factory are *better* because of scientific research in Scaife Laboratories. For example, the development of the new Scaife Dura-Lite LP-Gas Cylinder included a complete study of the deep-drawing process, using half-size parts made on the research department press shown above. This procedure, supplemented by complete metallurgical, physical, chemical and specialized studies, permits accurate evaluation of various materials, drawing methods and processing procedure. The result is a better, more serviceable product designed and made on sound engineering principles.

SCAIFE COMPANY

OAKMONT (Pittsburgh District), PENNA.

Makers of Pressure Vessels for Air, Gases and Liquids

Here is the "big brother" of the press shown at the top of the page. Full-size cylinder-half has been formed in one stroke of the press (see right) and is being removed for processing and assembly.



Starting with a circular sheet of steel—

a cup is formed by a conventional drawing operation.

A continuation of this pressing operation turns the cup "inside out" without removing it from the dies,

completing—in a single stroke—the deep-drawn shape, which becomes a cylinder-half. Shown below is the complete cylinder, a standard container for liquefied petroleum gas. Similar Scaife cylinders are used for freon, acetylene and other materials.

sumes 10 percent as much power and delivers 90 percent of input as useful output.

LONGER LIFE is expected from the new Exide Ultra Start automotive battery. Electric Storage Battery Co. reports these design changes: Silvium lead-silver alloy grid filled with a new lead-base active material, a milder electrolyte which, when reacting on the active material, does so at less expense to the battery's life; negative and positive plates insulated with new type separators made of Permex plastic.

ROTARY SWITCH ACTUATORS produce intermittent pulsed rotational motion up to 330 deg with torques tailored to fit given requirements. Drive consists of a miniature motor in a special circuit permitting rapid reciprocal switching up to ten cycles per sec. General Precision Laboratory, Pleasantville, New York.

A FAST-ACTING CLUTCH for use in high-speed computors is one of the latest devices to come out of the National Bureau of Standards in Washington. Three Bimorph flexible crystal plates bend when opposite potentials are applied to different parts of their surfaces. "Connection" between output disk and input disk is effected through a pressure plate.

TESTING

IT IS CUSTOMARY to report the fatigue strength of aluminum alloys after 500 million cycles. Tests run at Wright Field on specimens of 75S-T6 for eight billion cycles show there is a fatigue limit, which can be safely determined from data obtained during the 500-million-cycle test.

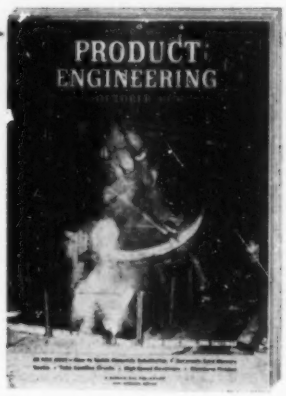
BOTH POSITIVE AND NEGATIVE peak values of transients can be continuously read on a new amplitude meter. Makers, Standard Telephones and Cables Ltd., Aldwych, London, say that voltages in range from 0 to 10 with a persistence of two milliseconds are indicated to accuracy of five percent.

MULTI-COMBINATION METER for electrolysis, corrosion and cathodic-protection testing can be connected into various circuits for measuring voltage, current, resistance and coil resistivity. M. C. Miller Co. of Englewood, N.J. uses a circuit selector switch and two high-sensitivity d-c instruments to do the job.

"BATTERY DOCTOR" automatically checks the condition of a storage battery. Designed by Signal Corps engineers at Fort Monmouth, N.J., instrument reveals amount of charge, electrolyte freezing temperature, rate of generator charge and overload conditions. Extreme weather conditions have no detrimental effects.

"PRESSURELESS" MEASUREMENT of thicknesses to 0.00002 in. are obtainable with a new electronic micrometer made by J. W. Dice Co. of Englewood, N.J. Circuit gives positive "on" and "off" indication with only 0.000005 in. desplacement at contact. Models are available with different work capacities for measurement on compressible or non-compressible materials, which can be either of the conducting or non-conducting variety.

RECORDER designed at Wright Air Development Center provides analysis of audio-frequency spectra. Automatic sweep of analyzer is obtained from a variable-speed velocity type servo.



THIS MONTH'S COVER

High strength steel is melted in a 25 ton capacity furnace at the west coast plant of the National Supply Company. It is poured either into ingot molds or into finished molds for oil industry machine and equipment components, or is cast into component structures for other basic industries such as mining, aviation, and metal working.

But with alloyed steels in short supply, particularly in industries not directly or indirectly supporting the military program, downgraded alloys and substitutes must be used in many applications. For a comprehensive report on this subject, covering all major metals and non-metals, see the feature article beginning on page 123.

YOU CAN TELL AT A GLANCE that the Job's OK

...when you use T & B Sta-Kon® Self-Insulated Terminals*

You can look right through the *translucent* nylon insulation on these new T & B Sta-Kon Self-Insulated Terminals—and *see* the stake mark that tells you the joint's electrically sound, mechanically strong.

These new components end the risk of shorts between closely-mounted terminals. Metallic portion retains all the proved advantages of the Sta-Kon design—high conductivity, permanent grip. Lightweight nylon insulation prevents metal-to-metal contact between terminals... *without* an extra insulating operation. It withstands action of gasoline, naptha, hydraulic fluids. It's *color-coded* for quick identification.

SIMPLE, SURE ASSEMBLY

One operation stakes terminal to wire with terrific force... holds wire insulation firmly inside terminal. SHURE-STAKE Hand Tools apply 1-ton staking pressure *every time*—jaws can't open till full force is exerted. Air tools available too—hand-held or bench-mounted.

*Patent Pending

THERE'S A T&B ENGINEERED PRODUCT for every wiring job in the complete T & B line of fittings for all conductors and raceways.

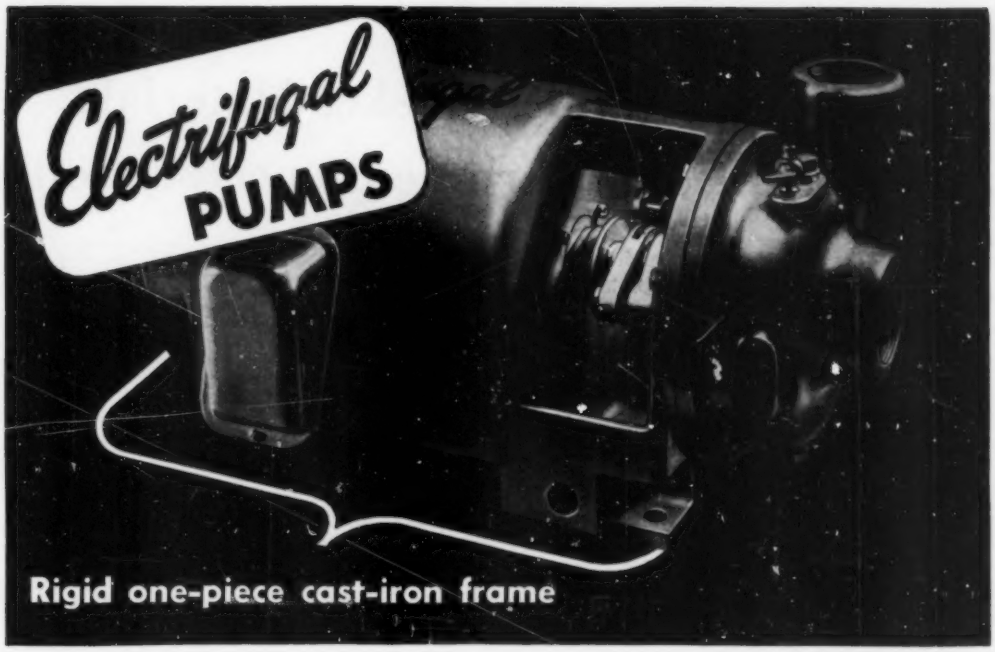
ENGINEERED RIGHT... DISTRIBUTED RIGHT! Sta-kon Self-Insulated Terminals are typical of the many T & B quality fittings recently re-designed to give you outstanding performance at lowest installed costs. Like all T & B fittings, they're furnished 100% through local T & B distributors under the T & B plan.

THE THOMAS & BETTS CO., INCORPORATED

16 Butler Street, Elizabeth 1, New Jersey

MANUFACTURERS OF ELECTRICAL FITTINGS SINCE 1898
ORIGINATORS OF SELF-INSULATED SOLDERLESS TERMINALS IN 1935

Our Field Design Engineers are ready to help you on special fittings problems. Ask your nearest T & B Distributor to arrange to have one get in touch with you.



This is the difference between close-coupled pumps

THIS EXCLUSIVE FRAME DESIGN combines maximum space for packing maintenance with exceptional rigidity in a way that no pump assembled to a standard motor can do. Solid cast iron with no joints from motor end housing to pump casing assures permanent alignment.

Bearings are lubricated at the factory and should require no attention for years. The stuffing box carries plenty of packing and all parts are generously proportioned for heavy duty service. As a result, your customers will find exceptional freedom from high maintenance costs.

Keep Your Costs Down, Too

You will like the *Electrifugal* pump because it makes your work easier and keeps your costs down. You can specify pump and motor as one unit without having to figure a drive. Every Allis-Chalmers pump representative is a competent application engineer who will help you select exactly the right pump for your needs. Motor and pump are designed for each other and made in the same plant. You have one responsible source of supply for both . . . one guarantee of satisfaction. And 94 Allis-Chalmers Certified Service Shops provide nation-wide factory approved service.

Talk over your pump selection problems with your nearest Allis-Chalmers Authorized Dealer or Sales Office, or write Allis-Chalmers, Milwaukee 1, Wisconsin and ask for Bulletins 52B6059 and 52B6140.

A-3324

Electrifugal, Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

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Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

Cork-and-Rubber Gasket Materials made to meet government specifications

There is an Armstrong material made to meet each of the 6 types included in the principal government specification covering cork-and-rubber gasket materials. These materials are listed below.

Government Specification	Armstrong Material
MIL-G-183 Type I Soft	NC-709
Type I Medium	NC-710
Type I Firm	NC-711
Type II Soft	DC-167
Type II Medium	DC-100
Type II Firm	DC-113
MIL-T-6841	DK-153 or RK-304S
MIL-T-6747	DK-149

For detailed information about these compositions and their application, please see Sweet's file for product designers or call your Armstrong representative. You can reach him at the nearest Armstrong Industrial Division office listed below.

Send for this gasket manual

You'll find up-to-date information on current government specifications and tentative SAE-ASTM specifications in "Armstrong's Gasket Materials."

You'll find, too, in this 24-page manual, a lot of helpful information on the design and use of gaskets. Included are discussions of subjects such as designing gaskets to reduce cost . . . practical tolerances for resilient gaskets . . . designing flanges for efficient sealing, and many others.

See "Armstrong's Gasket Materials" in Sweet's file for product designers. For a personal copy of this manual, write to Armstrong Cork Company, Gaskets and Packings Department, 7110 Arch St., Lancaster, Pa.

NEW 1951 EDITION

New cork-and-rubber compounds. Armstrong's Research Laboratories are ready to develop cork-and-rubber materials to meet new military requirements as they arise. Please discuss your needs with your nearest Armstrong representative . . . or write.

Cork compositions. There is an Armstrong Cork Composition made to meet each of the classes under Federal Specification HH-C-576, as well as the requirements of each of the grades under specification MIL-C-16090.

Synthetic rubber compounds. Armstrong manufactures highly specialized synthetic rubber compounds for certain critical applications. For example, Armstrong makes a rubber washer that meets the requirements of the aircraft fuel nozzles made under MIL-N-4180.

ARMSTRONG'S GASKET MATERIALS

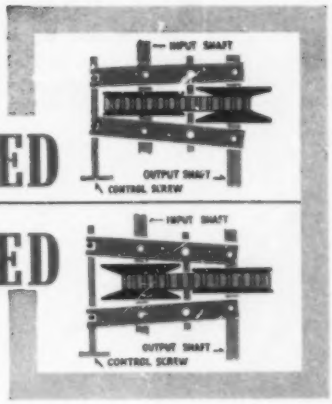
Your nearest Armstrong Industrial Division office

ALBANY 10, N. Y., 64 Northern Boulevard, Telephone: 4-0131 • BOSTON 16, MASS., 131 Clarendon Street, Telephone: COpley 7-2490 • CHICAGO 54, ILL., 13-136 Merchandise Mart, Telephone: DElaware 7-0500 • CINCINNATI 2, OHIO, Temple Bar Building, 138 E. Court Street, Telephone: PArkway 3220 • CLEVELAND 15, OHIO, 209 Hanna Bldg. Annex, Prospect Ave. and E. 14th Street, Telephone: MAin 7900 • DETROIT 26, MICH., 10th Floor, Free Press Building, 321 Lafayette Avenue, West, Telephone: WOodward 3-5670 • GREENVILLE, S. C., 33 Norwood Place, Telephone: Greenville 3-5302 • LOS ANGELES 15, CALIF., 719 Bendix Building, 1206 Maple Avenue, Telephone: RICHmond 0286 • NEW YORK 16, N. Y., 295 Fifth Avenue, Telephone: MUrray Hill 4-6900 • PHILADELPHIA 2, PA., Robinson Building, Fifteenth and Chestnut Streets, Telephone: LOcust 4-4290 • ST. LOUIS 3, MO., 1205 Olive Street, Telephone: CHestnut 1757 • In Canada: Armstrong Cork Canada Limited, 6911 Decarie Boulevard, Montreal, Quebec, Telephone: ATlantic 4733.

Only

with the P.I.V. variable speed drive can you go

from MAXIMUM SPEED



to MINIMUM SPEED

in an infinite number of positive settings!

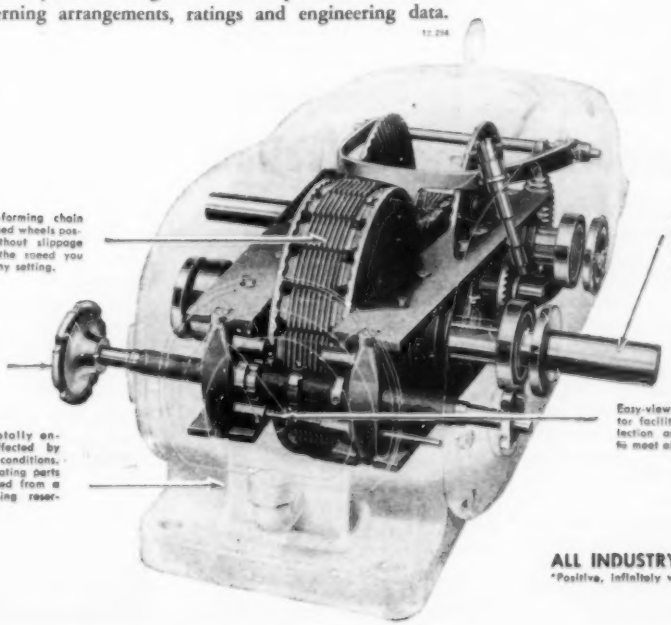
The operation of Link-Belt's P.I.V. Variable Speed Drive is not dependent upon friction for power transmission. Link-Belt's P.I.V. gives you exact speed selection in *positive*, infinitely variable settings . . . transmits full rated horsepower throughout its complete range.

Find out how Link-Belt's P.I.V. can increase the flexibility and efficiency of your machines. Call the branch office near you. Preselection of the right P.I.V. variable speed transmission for your needs can be readily obtained together with complete detailed information concerning arrangements, ratings and engineering data.

LINK-BELT P.I.V. VARIABLE SPEED DRIVE

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in Principal Cities.

12.216



Self-tooth-forming chain grips toothed wheels positively without slippage — gives the speed you need at any setting.

An infinite number of positive, stepless speed adjustments may be made with manual, electric, pneumatic or hydraulic controls.

All-metal, totally enclosed — unaffected by atmospheric conditions. All vital operating parts splash-lubricated from a common housing reservoir.

You can get minute speed changes and maintain them accurately while operating under full load.

Easy-view speed indicator facilitates speed selection and adjustments to meet all requirements.

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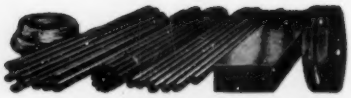
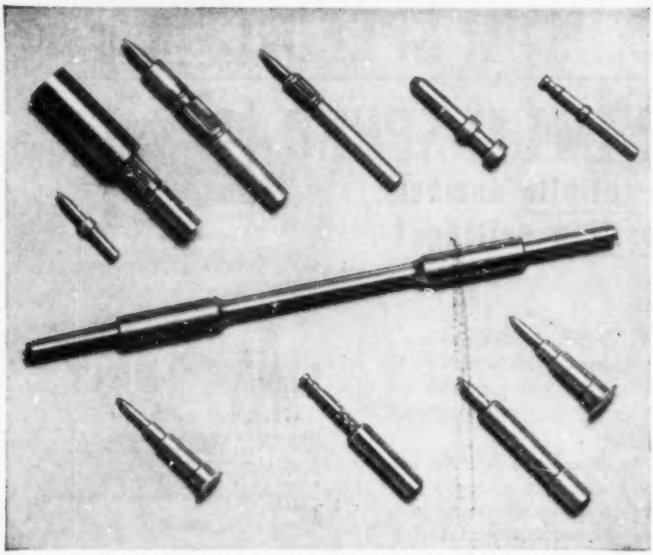
*Positive, Infinitely variable



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Examples of small parts produced accurately and economically on Swiss screw machines. Tapers on some parts generated on cutoff end to eliminate secondary machining operations. Courtesy Newtown Mfg. Co., Newtown, Conn. *(samples enlarged 35%)*

Taper Generated to Eliminate Secondary Machining Operation

Parts such as firing pins for fuses or electronic terminals with tapered points on one end, as well as operations on the opposite end, are often completed in the primary operation on Swiss screw machines. This is accomplished by generating the point on the cutoff end. Previously, this part was completed in a secondary operation.

In generating a taper, a single-point tool is used. The stock feed cam and the tool feed cam are synchronized to produce the required angle. Since the pressure of the single-point tool is almost negligible when compared to a broad-forming tool, distortion of the part is thereby reduced to a minimum, if not completely eliminated, and smoother finishes are obtained.

Unleaded Brass Used

The part in the lower right corner is a good example of such work. It is made from high brass rod (65% copper, 35% zinc) drawn to a spring temper. Without lead this alloy is generally not used in screw machines as the chip is long and stringy. However, the alloy and temper was used to obtain higher tensile strength and greater wearing qualities.

The overall length is .900 in. with one diameter .135 x 3/16 long, another .120 x ½ and the tapered diameter .065 x 7/32. A .090 drilled hole is put in the .135 diameter.

Drill Edges Rounded Over

The cutting edges of the drill were rounded over to produce a negative rake, thus causing the chip to come out in a long, unbroken curl. In this way clogging by chips was eliminated and drill breakage reduced.

In rounding over the cutting edge of the small spiral drills, it was found that a diamond wheel produced a finer finish which decreased the friction and also produced a cleaner hole. Care must be taken to prevent burring of the cutting edge.

Carbide tools were used on all the parts and only standard twist drills were used rather than the flat gun drill.

The cutting compound used was a heavy sulfur-base oil. The work discolored but tarnish was removed by dipping.

The difficulty of centering accurately prior to drilling was overcome by using a fixed cutting tool from the overhead post. By accurately turning the center, the possibility of the drill walking and breaking was considerably reduced.

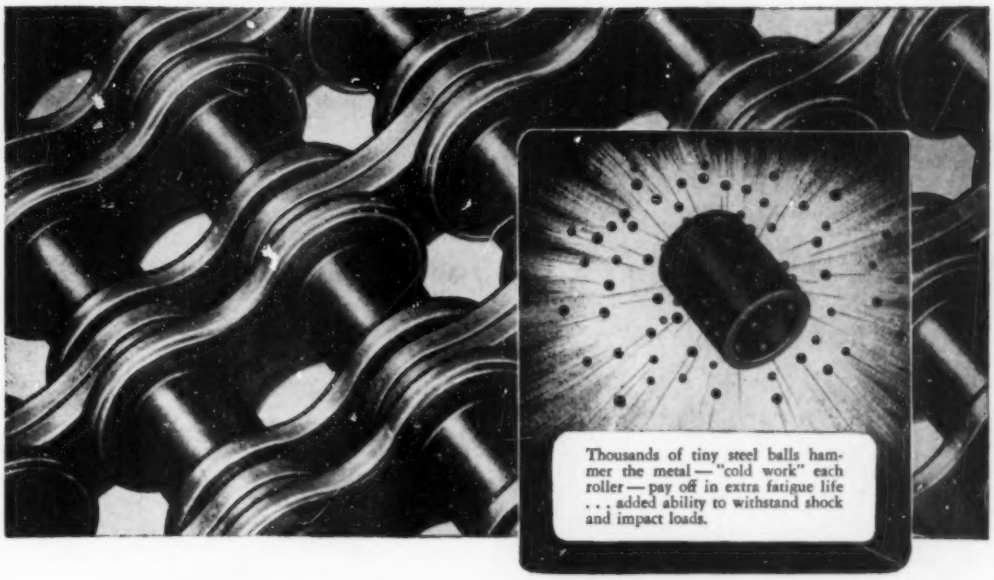
A spindle speed of 10,000 rpm was used with a feed of about 0.0009. For a better finish the feed can be reduced to around 0.0005.

Double Feed-Out Utilized

The length of the part in the center of the illustration theoretically was too great for the machine which matches the diameter of 5/32. However, by feeding twice without cutting off and supporting the work from the turret, it was possible to turn the three diameters, then cut off.

In cutting either leaded or unleaded copper-base alloys, no top rake was used and the clearance angles were between 5 and 10 degrees. High finishes were obtained by slightly breaking the edge of the cutting tools.

For information on the cutting characteristics of various alloys and information on machining them, write on company letterhead for Bridgeport Brass "Technical Handbook." If additional help is needed, contact our Laboratory. (7281)


Thousands of tiny steel balls hammer the metal — "cold work" each roller — pay off in extra fatigue life . . . added ability to withstand shock and impact loads.

Why you should be sure the roller chain you buy has

SHOT-PEENED ROLLERS

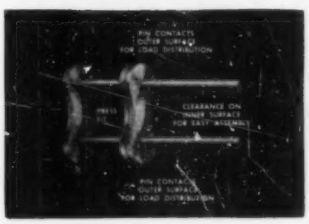
. . . one of the extra-strength features you get with every LINK-BELT Roller Chain

LOOK for the distinguishing darkened rollers on every roller chain you buy! They're your guarantee of extra fatigue life.

Shot-peening is just one of the added manufacturing refinements that make Link-Belt Precision Steel Roller Chain a longer-life chain. Controlled material selection and heat treating assure absolute uniformity . . . no weak members.

Link-Belt Roller Chain is available in single or multiple widths, in ⅜ to 3 in. single and double pitch. For the best in roller chain, get in touch with your nearest Link-Belt office.

Easier coupling and uncoupling without sacrificing load distribution



Patented E-Z Assembly feature of Link-Belt Precision Steel Roller Chain has won world-wide approval. Coupling and uncoupling of multiple width chains—right on the job—is far easier. There's absolutely no sacrifice of load distribution . . . no loss of the chain's remarkable performance. Press-fits between chain pins and middle bars have been modified. But full load-carrying capacity across the entire width of the chain has been maintained.

LINK-BELT

PRECISION STEEL ROLLER CHAIN

LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices, Factory Branch Stores and Distributors in principal cities. 15,500

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THE MOST TRUSTED NAME IN MAGNETOS

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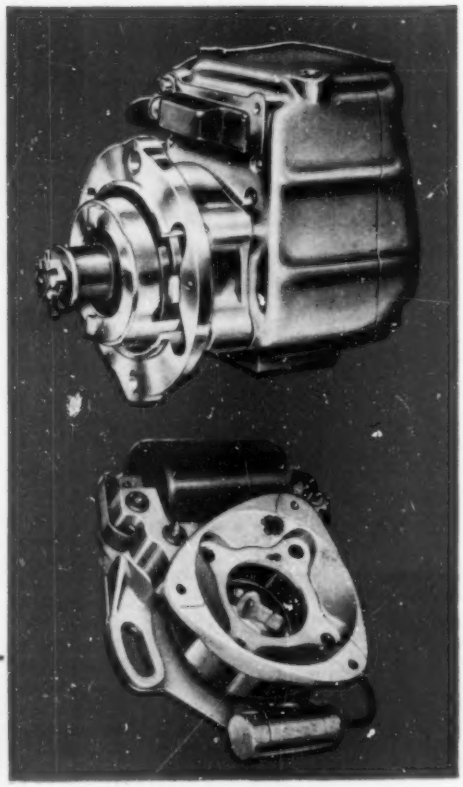
√ Constant spark over entire speed range.
√ Compact and sturdy construction.



Whether you purchase a small engine for outboard, industrial or marine use, today's foremost consideration should be long life and trouble-free performance. Therefore, it will pay you well to insist on Bendix magnetos in the engine you select. For the basic design of Bendix magnetos assures quality performance for *every type* of small engine and *every pricing requirement.* Remember it pays to specify Bendix, the most trusted name in magnetos. Complete information available on request.

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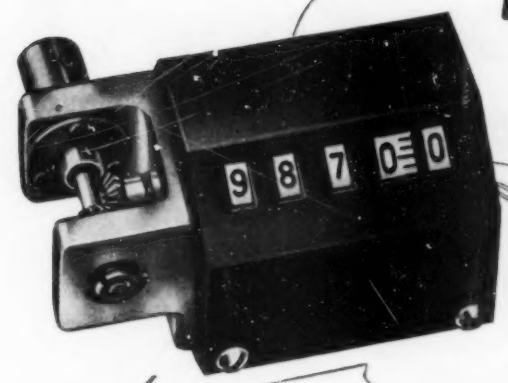

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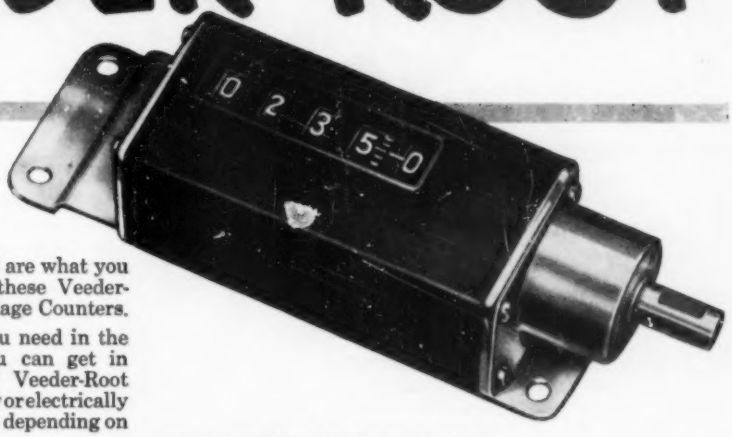
Everyone Can Count on VEEDER-ROOT



LONG-RANGE EYES are what you really have here, in these Veeder-Root High-Speed Yardage Counters.

And anything else you need in the way of *Count*rol, you can get in standard or special Veeder-Root Counters, mechanically or electrically operated . . . deliveries depending on D-O ratings, of course.

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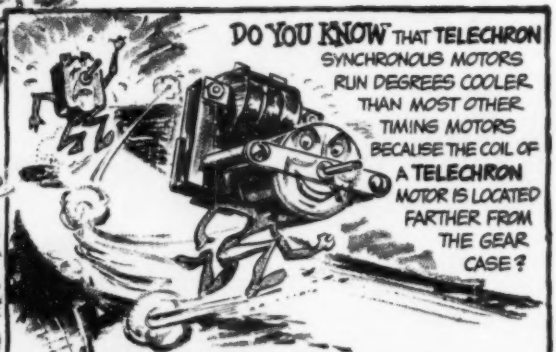
Do You Know?

DO YOU KNOW THAT AIRCRAFT FLIGHT RECORDERS WHICH CHART A CONTINUOUS LOG OF VARIABLE CONDITIONS DEPEND FOR THEIR ACCURATE TIMING ON **TELECHRON** SYNCHRONOUS MOTORS?

30,000,000,000

DO YOU KNOW THAT THE ROTOR SHAFTS OF MANY **TELECHRON** SYNCHRONOUS TIMING MOTORS HAVE MADE MORE THAN **30 BILLION** CONTINUOUS REVOLUTIONS AND THAT THE MOTORS ARE STILL OPERATING AS ACCURATELY AND DEPENDABLY AS WHEN THEY WERE NEW?

NEED SKILLED HELP ON "EMERGENCY" CONTRACTS? TELECHRON INC. HAS AVAILABLE CAPACITY FOR DEFENSE ORDERS. NEW BROCHURE, "PRECISION ON THE PRODUCTION LINE," GIVES A QUICK PICTURE OF PERSONNEL CAPABILITIES AND MASS PRODUCTION FACILITIES. *WRITE FOR YOUR COPY TODAY.*



DO YOU KNOW THAT **TELECHRON** SYNCHRONOUS MOTORS RUN DEGREES COOLER THAN MOST OTHER TIMING MOTORS BECAUSE THE COIL OF A **TELECHRON** MOTOR IS LOCATED FARTHER FROM THE GEAR CASE?

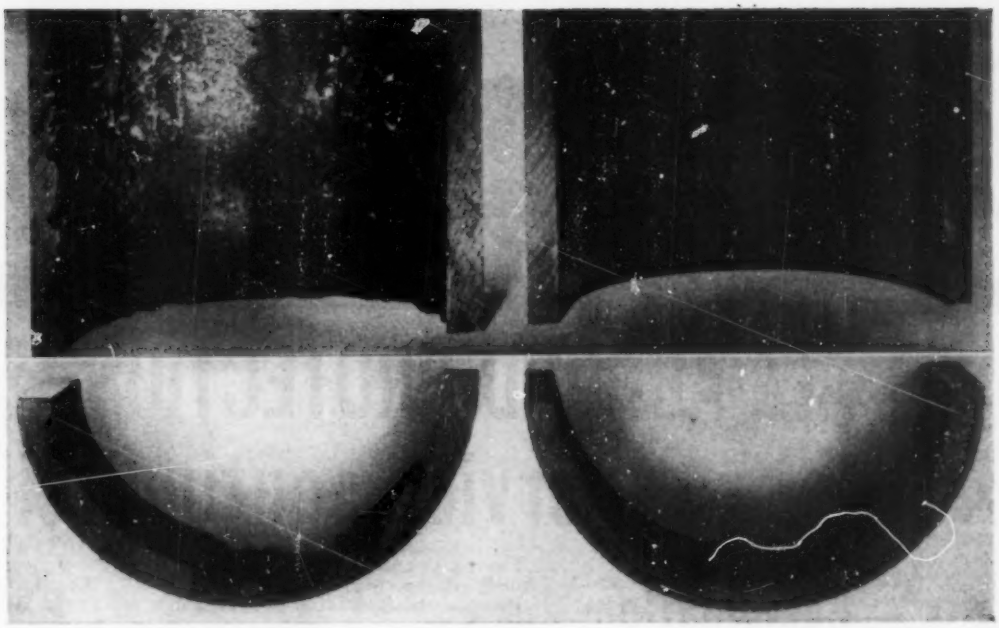
READ ALL ABOUT TELECHRON MOTORS IN THIS BULLETIN

WRITE FOR BULLETIN IS-110 WHICH CONTAINS CHARTS, TORQUE RATINGS AND COMPLETE SPECIFICATIONS ON **TELECHRON** SYNCHRONOUS MOTORS FOR USE IN TIMERS, TIME SWITCHES, RECORDING AND CONTROLLING INSTRUMENTS, COST RECORDERS, CYCLE CONTROLLERS, ETC. TELECHRON INC., 110 UNION ST., ASHLAND, MASS. A GENERAL ELECTRIC AFFILIATE.

Telechron®

ALL TELECHRON TIMING MOTORS ARE

INSTANTLY...CONSTANTLY SYNCHRONOUS



Don't Let Corrosion Steal Your Steel!

A major oil company coated the inside of 4-inch steel tubing with finishes based on VINYLITE Brand Resins. Each day, for five months, the pipe carried 100 barrels of oil and 5,000 barrels of high-iodine-content salt water. It was directly coupled to an uncoated pipe.

The coated pipe (right) suffered no measurable damage. The uncoated pipe (left) corroded as deeply as a quarter of an inch — two-thirds of the way through the pipe.

Preserving metal and slashing maintenance costs, coatings based on VINYLITE Resins are widely used today in the petroleum, chemical, and processing industries... because they resist water, salt air, industrial atmospheres, oils, greases, alkalies, most strong acids, sunlight, heat, cold. Odorless, tasteless, non-flammable, they protect containers from contents, contents from containers.

We'll gladly send you a list of suppliers of metal, concrete and masonry coatings based on VINYLITE Resins. Write Dept. KX-10.

Coatings illustrated applied by Liquid Plastics Co., 640 N. Broad Ave., Wilmington, California and produced by Plastic Coating Corp., Houston 19, Texas, and 30 Rockefeller Plaza, New York 20, N. Y.

Vinylite
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A Division of
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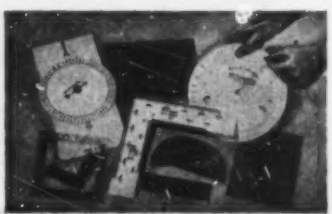
UTMOST SAFETY against spillage of toilet bowl cleaning fluid, plus impact and chemical resistance, are achieved by handy "Koaster Kit" of VINYLITE Plastic Flexible Compound molded for National Laboratories, Inc., 4934 Lewis Ave., Toledo, Ohio, by Peerless Molded Plastics Co., Division and Hamilton Sts., Toledo.

UTMOST PROTECTION for tube and pipe ends and threads during shipping, storage, handling, is given by these "Elastoplastic" caps and plugs molded at top speed and economy from VINYLITE Elastomeric Compounds. Resist oil, grease, moisture, dirt, chemicals. By Plastics Div., S. S. White Dental Mfg. Co., 10 E. 40 St., New York 16, N. Y.



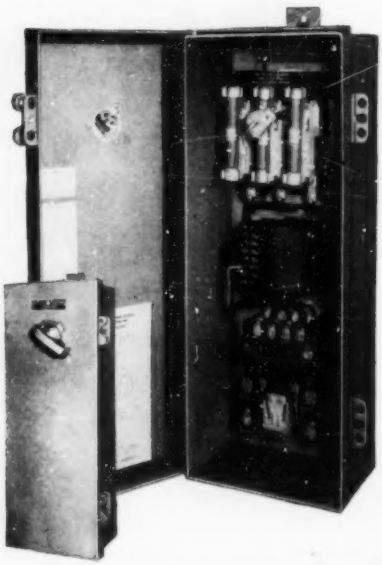
UTMOST DURABILITY is assured for artillery training instruments made of stable VINYLITE Rigid Sheets that hold shape and dimensions despite temperature changes, moisture. Resist wear, oils, greases, chemicals. Permanently printed. Pleasant touch. Easily cleaned. Instruments by Advertising Displays, Inc., Covington, Ky.

Designer's

ALL-AROUND PROTECTION —for top service continuity!

Combination Starters

to meet J. I. C. standards



Here is General Electric's newest combination starter—designed especially to meet Joint Industry Conference electrical standards. Now—in addition to well-known G-E starter features that designers associate with long life and dependability, ease of installation and servicing—new features have been incorporated. These new starters, for the automotive and other industries operating in atmospheres laden with abrasive dust and cutting oils, offer greater protection to men and equipment, greater continuity of service.

NEMA Type 12 enclosure protects components

- Tightly-sealed enclosure of heavy-gage steel, with full welded seams, has drip shield across top, and no knockouts or openings to allow oil, dust or moisture to seep inside.
- Door, fitted with oil-resistant gasket, is held closed by two screw fittings, fastened or unfastened by screwdriver.
- Case, with welded-on exterior mounting feet at top and bottom, is treated with corrosion-resistant paint finish. External mounting bracket provides space between back of enclosure and wall for oil drainage.

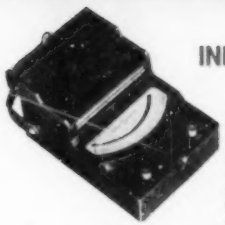
Other features add extra protection

- Cover cannot be opened when disconnect switch (or circuit breaker), with which it is mechanically interlocked, is in "on" position.
- Machine-tool type control transformer has a dual voltage primary and a 110-volt secondary.
- All wiring is color coded and heavily insulated.

These new G-E starters for J.I.C. "specs"—reversing or nonreversing—are available in sizes 1 to 5 for 200-, 440-, and 550-volt a-c motors up to 100 hp. For more information, write for new Bulletin GEA-5715.

GENERAL ELECTRIC

Digest GE PRODUCT HIGHLIGHTS



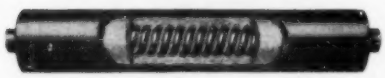
INDICATING INSTRUMENTS

— to test your new designs!

Before going into production on your new designs, test the prototypes with dependable General Electric indicating instruments. In a-c and d-c types, conveniently portable, and accurate to ± ¾ of 1 per cent of full-scale value, they include voltmeters, ammeters, milliammeters, wattmeters, and volt-wattmeters. For condensed data on these and other G-E instruments for measuring, indicating, and testing, see Bulletin GEA-5469.

ELECTRIC HEATERS

—to get it hot the easy way!



Without involved piping and costly equipment, you can get "on-the-spot" heat when and where your machine or process needs it—simply by specifying the right electric heater from General Electric's wide line. Included are immersion, strip, cartridge, tubular, fin, and unit heaters as well as heating cable—all providing clean, convenient, easily-controlled heat. Send for specialized booklets on recommended types to use for heating surfaces (GEA-5097), liquids (GEA-5077), process air (GEA-5096), pipelines (GEA-5095), and for melting soft metals (GEA-5098).

MOTOR COURSE

—to simplify selection and application!

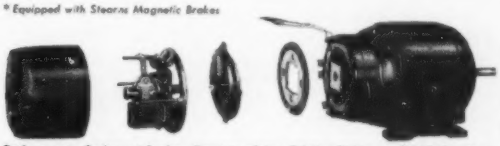
New, helpful, interesting—that's General Electric's Motor Selection and Application Course. A valuable aid in training your personnel, this "More Power to America" program comprises nine short, easy-to-take lessons. The complete kit includes slide films with sound, review booklets, and instructor's manual. Latter is available free through your G-E representative. For more information on the course, ask for Bulletin GEA-4938-16.

SAVE TIME AND TROUBLE— SPECIFY ONE UNIT ON ONE ORDER!

TRI CLAD UNIT BRAKE-MOTORS*

No need to engineer brake to motor when your design calls for a brake. Just specify a General Electric Tri-Clad unit brake-motor, an integrally-built, compact unit that's easy to order, saves space on your machine. Available with most types of Tri-Clad motors in ratings up to 20 hp, 90 lb-ft static torque. See Bulletin GEA-5464.

* *Equipped with Stearns Magnetic Brakes*



Brake cover | Spring-set brake | Pressure plate | Friction lining | Tri-Clad motor

General Electric Company, Section B 568-91
Schenectady 5, New York.

Please send me the following bulletins:

- ☐ for reference purposes
- ☐ in connection with immediate projects

- ☐ GEA-4938-16 Motor course
- ☐ GEA-5077 Heaters for liquids
- ☐ GEA-5095 Heaters for pipelines
- ☐ GEA-5096 Heaters for process air
- ☐ GEA-5097 Heaters for surfaces
- ☐ GEA-5098 Heaters for melting soft metals
- ☐ GEA-5464 Tri-Clad brake-motors
- ☐ GEA-5469 Testing instruments
- ☐ GEA-5715 J.I.C. starters

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VICKERS multiple unit valves for the best hydraulic control of mobile equipment

NEW!

Vickers Multiple Unit Valves provide every desirable feature of custom design at production-line prices. Vickers sectionalized construction permits you to specify the exact control functions needed and no others; yet you pay no special design or production costs.

To meet various control needs (original specification or conversion) and to make many combinations without unwieldy inventory . . . use the Vickers sectionalized valve assembly.

To control motion positively and accurately . . . you get Vickers exclusive load inching control (also makes it nearly impossible to jar or dump a load unintentionally).

To obtain any type and size of valve unit . . . Vickers provides 11 types of valve sections in four pipe sizes.

To hold load position while operating other machine components or while pump drive is stopped . . . Vickers has the back flow prevention check valve.

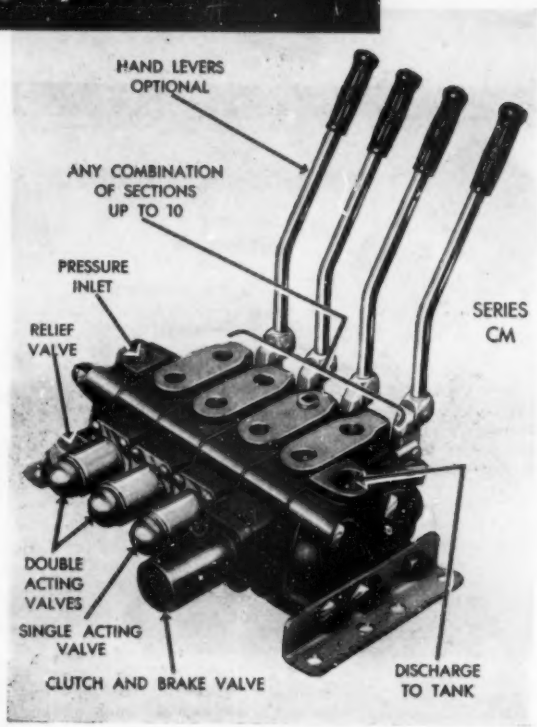
To prevent overload and damage to machinery . . . the assembly includes a Vickers positive-acting factory preset relief valve.

To assure a leak-proof, drip-proof system . . . Vickers nested "O" ring seals between valve sections and on valve plungers.

To make valve operation complete . . . Vickers furnishes spring loaded valve plungers (rugged operating levers optional).

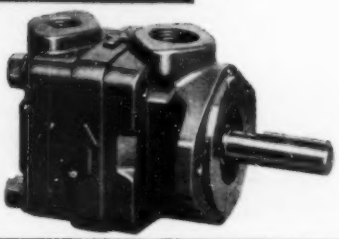
To get full capacity for piping or tubing size . . . Vickers rates valves conservatively at 18 gpm for the ½" size up to 48 gpm for 1".

To obtain the utmost in performance and dependability . . . use a 100% Vickers hydraulic system including Vickers Vane Type Pumps. (See below.)



VICKERS balanced vane pumps for mobile equipment

These pumps are tough and long-wearing. Hydraulically balanced construction eliminates pressure-induced bearing loads. Automatic wear compensation maintains correct radial and axial running clearances throughout pump life . . . efficiency and delivery rate remains high. Series V-200, V-300 and V-400 range in capacity from 2 to 73 gpm. Operating pressures up to 1500 psi. Available also as double pump. Get full details from the Vickers Application office near you, or write for Catalog M-5100.



4495

ASK FOR → *New Catalog* M-5100

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
1454 OAKMAN BLVD. • DETROIT 32, MICH.

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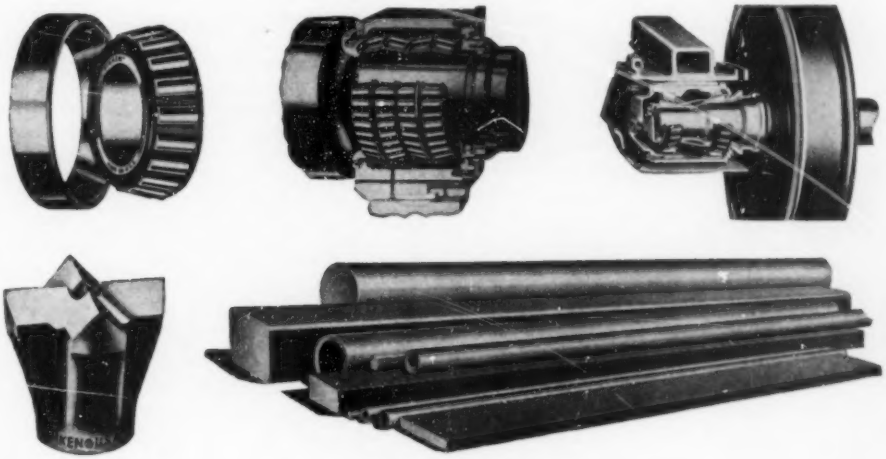
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.



Little words that mean a lot

There's no room for compromise, doubt or question in those brief words above. They mean: "Timken" is the registered trade-mark of The Timken Roller Bearing Company. And that meaning is mighty important to you.

The trade-mark "Timken" assures you of getting the highest quality tapered roller bearings, fine alloy steel bars, steel tubing or rock bits—all products of The Timken Roller Bearing Company.

That's why it pays to remember that "Timken" *is* a trade-mark, not a type of product. That it isn't really a product of the Timken Company unless it's backed up with this trade-mark.

Why not make it a habit to look for the trade-mark "Timken" when you buy tapered roller bearings, alloy steel bars, tubing or rock bits. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

TIMKEN

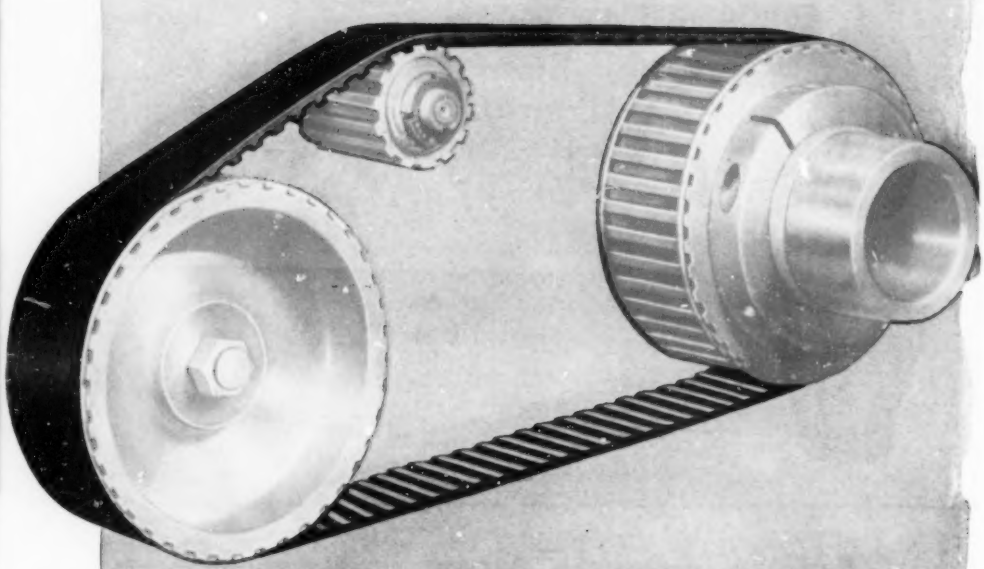
TRADE-MARK REG. U. S. PAT. OFF.

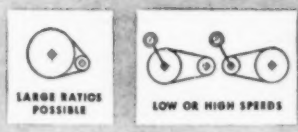
TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂ THE TIMKEN TAPERED ROLLER ⊂ BEARING TAKES RADIAL ⊂ AND THRUST → LOADS OR ANY COMBINATION

All grip... NO SLIP!

GILMER





GILMER "TIMING BELT" PATENTS 1930

"TIMING BELT"* DRIVE

—designer's problem-solver

A revolutionary *tooth-grip* belt that has already improved the performance of thousands of machines—is daily solving new problems in power drive design!

The Gilmer "Timing Belt" is an exceptionally strong, *precision-power* belt: Belt teeth make positive engagement with axially grooved pulleys . . . speeds of driver and driven pulleys synchronize perfectly —there is no speed variation, angular velocity is constant.

And consider the construction! Steel cable pulling elements give enormous tensile strength—eliminate stretch. Where constant starts and stops are a factor, this extra strength reduces inertia by minimizing pulley weight. Body of belt is tough oil- and heat-resistant Neoprene for sturdy, long lasting service.

The Gilmer "Timing Belt" is *versatile:* You can use it for synchronizing drives, for power transmission, for functional operation! Let our engineers help design your drive. We'll be glad to send you an illustrated brochure which shows how leading design engineers are using it; gives valuable suggestions for drive designing. Write for it.

*Reg. Trade Mark

9 "TIMING BELT" "NO'S" Worth noting:

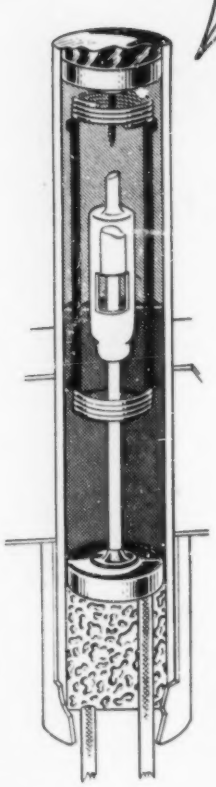
NO SLIP!
NO CREEP!
NO STRETCH!
NO SPEED VARIATION!
NO INITIAL TENSION!
NO POWER WASTE!
NO LUBRICATION!
NO ADJUSTING!
NO BACKLASH!

Gilmer BELTS

L. H. GILMER COMPANY
1010 Tacony, Philadelphia 35, Pa.
Division of United States Rubber Company

Mercury Relay Stainless Tubing Specifications:

Type 304: Super Finish on ID
OD tolerance ±.003"
ID tolerance +.000"
−.006"



Super finish needed on the inside, to permit ID broaching without so much as a scratch or a pinhole! Tolerances have to be held just right on tube after tube after tube!

Right there you have this manufacturer's reason for specifying *Carpenter* Stainless Tubing over a long period of years.

When you have a Stainless Tubing problem that requires something extra in mill experience and product quality, it will pay you to get in touch with Carpenter. Let us work with your engineers in the development of *your* future products.

Slide Chart on Bending Stainless Tubing gives recommended bending radii and coil diameters for various sizes and gauges. To get good results on bending jobs and avoid waste of critical material, write for your copy.

THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N. J.
Export Dept.: The Carpenter Steel Co., Reading, Pa.—"CARSTEELCO"

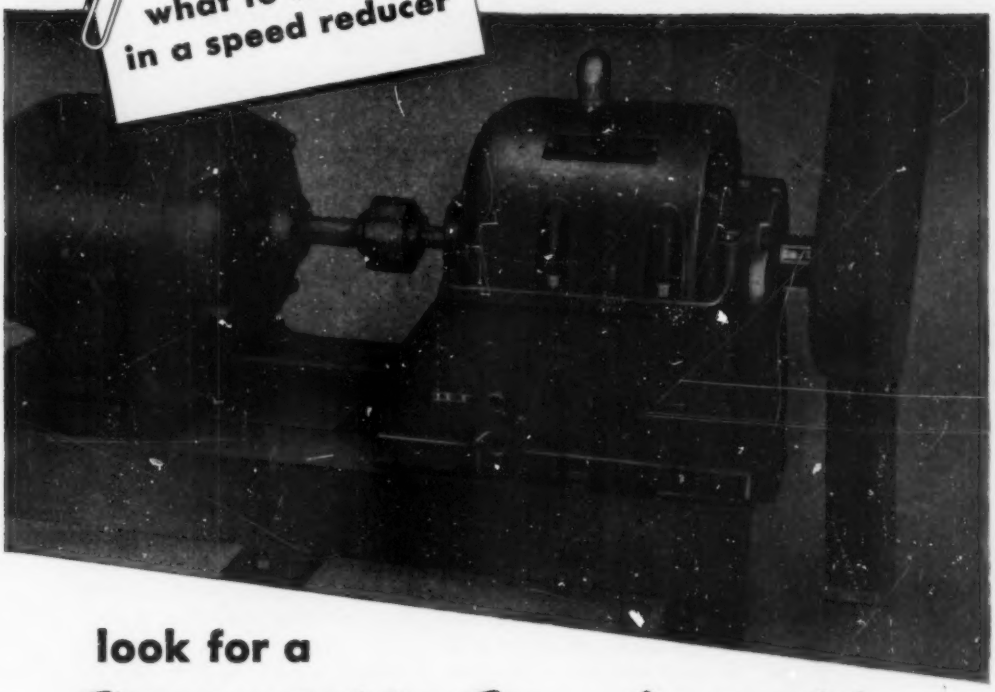
Carpenter
STAINLESS TUBING

Analysis · Tolerance · Finish

—guaranteed on every shipment

THE U.S. NEEDS YOUR STEEL SCRAP NOW

what to look for in a speed reducer



look for a

Dependable Gear Assembly

Tough, impact-resisting gears are the foundation for the dependable operation of Westinghouse Speed Reducers. Each gear is made from BPT Taper-Hardened Gear Steel, combining carefully selected material with an exclusive Westinghouse heat-treating process. Result is gearing with a hard, wear-resistant surface that tapers evenly to a tough, ductile core. Teeth will not chip, crack or spall.

Further dependability is provided by the *accuracy* of Westinghouse Gears. Teeth are cut by the hobbing process—recognized as the most accurate method of gear cutting. Tooth contours are precise and highly finished. Operation is smooth and quiet. The single helical design distributes load evenly, with uniform tooth deflection—large tooth contact area—long life with minimum wear.

You get such a dependable gear assembly in the new Westinghouse "DB" Speed Reducer pictured above. This concentric shaft, split housing-type speed reducer fills the bill where floor space is limited. Construction permits straight-line mounting of speed reducer and prime mover.

There's a Westinghouse product to meet each of your gearing requirements — speed reducers, gearmotors, high-speed units, open gearing. Contact your Westinghouse representative for a copy of Descriptive Bulletin 3700-ISR. Or write Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pennsylvania.

J-07302

YOU CAN BE SURE... IF IT'S Westinghouse

GEARED DRIVES

Fire extinguishers must

. . . that's why the pistons in

BUFFALO better-built

"VL" EXTINGUISHERS are formed and ground from

GRAPHITAR

(CARBON-GRAPHITE)

GRAPHITAR pistons in the efficient extinguishers manufactured by the Buffalo Fire Appliance Corp. of Dayton, Ohio are a positive guarantee that these extinguishers are always ready for instant use . . . no matter how long they stand idle between uses. The chemical inertness of **Graphitar** is assurance that the piston will not be corroded or changed in any way by the chemical in the extinguisher. The stable, non-warping qualities of **Graphitar** are assurance that, after long periods of immersion in the extinguisher fluids, the piston will not warp, swell or stick in the cylinder. The great versatility of **Graphitar** makes it an ideal material for many such difficult applications . . . few materials have answered so many and such varied industrial needs.

THE UNITED STATES

always be ready for immediate action

Graphitar is a non-metallic, exclusive-formula product of carbon and graphite that has found many specialized uses in many industries. It is chemically inert . . . cannot be harmed even by boiling concentrations of corrosive acids, and it remains unaffected in the presence of extremes of heat or cold. It is harder than steel yet as light as magnesium. It is a good conductor of electricity and is not harmed by electrical current. It is easily formed into strong seals, bearings, rings, pistons and parts of almost any shape . . . it can be ground to tolerances as close as .0005" in smaller sizes. Our engineers may be able to suggest **Graphitar** applications that will improve the efficiency of *your* products. Send us sketches or prints for recommendations without obligation . . . ask for your copy of the 55 page **Graphitar** catalog.

149

GRAPHITE COMPANY

DIVISION OF THE [illegible]

ANYBOD
can weld it!

MAGNESIUM

That's right! If they can weld any metal, they can weld magnesium. Nearly all of the common welding techniques can be employed. Inert-gas shielded arc welding, gas welding, and electric resistance welding are all being used successfully on magnesium.

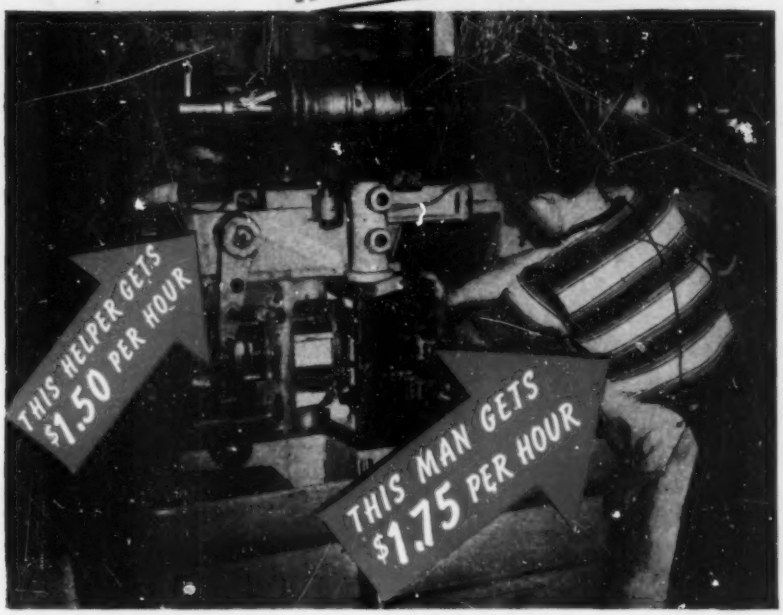
Most forms of magnesium are weldable. While joint strengths will vary with different alloys, typical properties of welded butt joints show tensile strengths up to 42,000 psi. and elongation up to 12%. In addition, magnesium welds are comprised of dense metal and are substantially free of microporosity.

The combination of relatively high weld strength and minimum specific gravity found in magnesium generally permits the design of welded magnesium structures that are lighter, stronger, and more rigid than is possible in other light metals. Dow has over 30 years of experience in the production and fabrication of magnesium —a call to your nearest Dow sales office will put this knowle lge at your disposal.

THE DOW CHEMICAL COMPANY
Magnesium Department • *Midland, Michigan*

New York • Boston • Philadelphia • Washington • Atlanta • Cleveland
Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

DON'T BE PENNY WISE *and* DOLLAR FOOLISH WHEN IT COMES TO GEARS



Down time (for disassembly, gear replacement, reassembly) — 4 hrs. minimum $13.00

Loss of 4 hrs. profit and overhead on this job $48.00

Sixty dollars lost because they "saved" ten per cent on a $10.00 pair of gears by buying inferior gears that quickly wore out and had to be replaced by BOSTON Gears ..... NET LOSS $60.00

Standardize on Stock Boston Gears

Design them into your equipment

Always specify them for replacements

BOSTON GEAR WORKS

71 HAYWARD ST., QUINCY 71, MASS.

BOSTON STOCKS ARE Best

AKRON, OHIO
ALBANY, NEW YORK
ALLENTOWN, PENNSYLVANIA
ATLANTA, GEORGIA
BALTIMORE, MARYLAND
BIRMINGHAM, ALABAMA
BOSTON, MASSACHUSETTS
BRIDGEPORT, CONNECTICUT
BROOKLYN, NEW YORK
BUFFALO, NEW YORK
CHARLOTTE, NORTH CAROLINA
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WILKES BARRE, PENNSYLVANIA
WINSTON-SALEM, NORTH CAROLINA
WORCESTER, MASSACHUSETTS

Work
There's a
Wallace
Barnes
Spring
to do it!
Bristol, Conn.

Government regulations limit the use of aluminum for other than essential projects. The facts presented here are to help you speed this essential work and get the most out of available metal.

Many will be working with it in new forms as they help America rearm. Here Alcoa presents useful information on the latest methods of Fabrication and Design Techniques.

CONTENTS

Aluminum Impact Extrusions
Magnesium
Aluminum Die Castings
Finishing Aluminum
Aluminum Castings
Aluminum Fasteners
Aluminum Screw Machine Stock
Aluminum Extrusions

Various aluminum impact extrusions showing interesting design possibilities such as internal and external projections, heavy sections, thick bottoms combined with thin walls and large over-all size.

Aluminum Impact Extrusions

The trend is to larger, more complicated parts having better finish and closer tolerances. New Alcoa developments offer designers interesting possibilities.

High Strength. An increasing proportion of impact extruded shells is being produced in tough, heat treated alloys. In addition to the medium strength alloys, considerable success has been attained with the high strength alloys 14S and 75S with tensile strengths of 70,000 psi or greater.

Stepped Extrusions. Utilizing the stepped extrusion principle it is possible, within certain limits, to step out the open end portion of a shell to a larger diameter. This is accomplished during extrusion without the necessity of a secondary expanding operation.

Multiple Wall Extrusions. Extruded shells with a centrally located internal hollow tube integral with the bottom and side wall are now being produced on a production basis. Alcoa will welcome the opportunity of working with design engineers to develop shells with one or more integral internal tubes.

Lateral Extrusions. A new development in the impact extrusion art is extrusion in a lateral direction. Articles having a central hub section can be made with arms or spokes of various cross sectional shapes. The lengths of the arms or spokes depend upon the intricacy of the article's design.

Solid Shapes. Many designers consider impact extrusions only for hollow, cylindrical or cup-shaped parts. Actually, Alcoa produces many solid and semi-solid impacts as well. These are also available in the tough, heat-treatable alloys, and are used as blanks for subsequent machining operations; in some cases it is possible to eliminate machining entirely. Often the saving in scrap loss more than offsets the slightly higher cost compared to bar stock.

Alcoa has limited impact extrusion capacity available to manufacturers with authorized production schedules and metal allotments. All designers should have a copy of the free, 43-page handbook, "Alcoa Aluminum Impact Extrusions."

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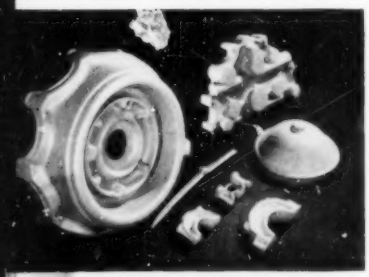
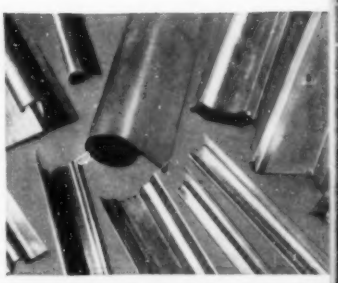
Magnesium

The same Alcoa facilities that cast, forge and extrude aluminum are also equipped for similar operations in magnesium.



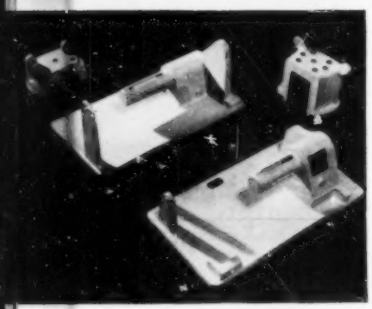
FORGINGS

Although not as strong as aluminum forgings, magnesium is used where weight saving is of vital importance. Sometimes a limit is reached in reducing sections of aluminum forgings to cut weight. Direct substitution of magnesium for aluminum results in a one-third weight saving.



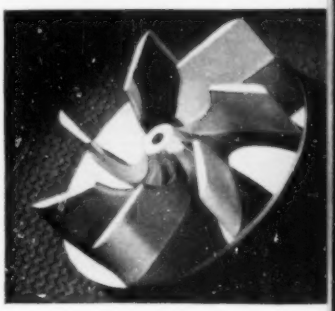
EXTRUDED SHAPES

The cross sections of magnesium extrusions may often be designed to obtain the stiffness and strength of steel with the lightness of wood. Magnesium extruded shapes combine maximum structural efficiency with minimum weight and cost.



DIE CASTINGS

Magnesium may be cast with nearly the same close dimensional tolerances and standards of draft as zinc die castings. It machines faster than any of the die casting metals. Its lighter weight makes the cost per casting extremely attractive.



CASTINGS

Both sand and permanent mold castings of magnesium are produced by Alcoa foundries. Frequently, magnesium castings are used to replace riveted aluminum assemblies. Although weight is not always reduced, the change simplifies construction and reduces labor cost. Magnesium castings often compete with cast iron in price.

Aluminum Die Castings

Careful choice of a supplier is an important step in guaranteeing the performance that the engineer designs into a part. Consider the facilities of Alcoa's two modern plants.

Location

Plants at Garwood, New Jersey and Chicago, Illinois are strategically located to serve the heart of the metal-working industry. Shipping time is short and expenses are low. Close liaison with the plants is possible.

Experience

Alcoa Die Castings are backed by 36 years of continuous operation — 63 years of aluminum experience. Alcoa casts only aluminum and magnesium. Machines, toolroom facilities and metallurgical laboratories are highly specialized for light metal castings — personnel are "old hands" at working with aluminum and magnesium.

Design Help

Each of the Alcoa district sales offices has a sales engi- .er who is ready to serve you. He is instantly available for design consultation, and will efficiently interpret your design and production requirements to Alcoa's large staff of die casting specialists at either plant.

ALCOA

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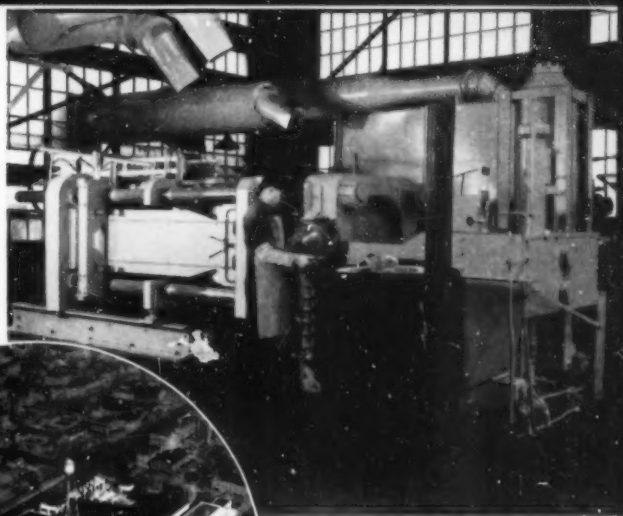
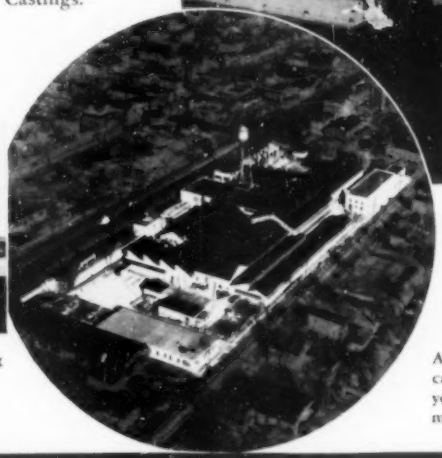
Capacity

You can depend on, and schedule your production to Alcoa quotations and delivery promises. Alcoa has open capacity available to manufacturers with authorized production schedules and metal allotments. Your local Alcoa sales office, listed under "aluminum" in the classified phone book, will supply prompt quotations. Write for a free copy of the 188-page designers' handbook, "Designing for Aluminum Die Castings."



Typical of the large die casting machines specially designed by Alcoa for use in our two modern plants.

Alcoa's new die casting plant at Chicago, Illinois.



Alcoa's Garwood, N. J. die casting plant — established 29 years — recently expanded and modernized.

Finishing Aluminum

Paint finishes offer pleasing decorative effects and excellent protection at extremely low cost. Simple procedures guarantee good results.

Baked-on enamel finish applied to spotting scope made of aluminum.

Cleaning. The simplest, but least effective method is to wipe with cloths or brushes saturated with mineral spirits. More effective methods are solvent vapor degreasing, solvent emulsion or inhibited alkaline cleaning. Chemical or electrochemical treatments used in conjunction with suitable cleaning methods are recommended for severe exposure conditions.

Priming Primers should resist moisture penetration, adhere well, form a good base for second coats and should contain an inhibitive pigment. Primers containing zinc chromate have all these properties. In many cases, aluminum pigmented primers are very satisfactory. Wash coat primers produce excellent results. The use of lead pigments should be avoided.

Finishing Coats. Any durable paint, enamel or lacquer may be sprayed, brushed or dip-coated on aluminum once it is suitably primed. In using lacquer, the primer coat must be compatible with the lacquer finishing coats. Bituminous paints, used to protect aluminum from alkalies, should be applied over a primer of the type.

Complete information on painting as well as plating, and finishing by chemical, electrochemical and mechanical methods is available at your local Alcoa sales office.

Aluminum seals with enamel finishes.

ALCOA

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Have you a "little" million dollar opportunity like this?

This is how a saving of a few mils on a lamp base can be multiplied by 830,000,000—the average number of incandescent lamps sold each year.

Engineers of two major lamp manufacturers had looked hard at the price advantage of aluminum over brass. A difference that made them agree with our suggestion, "It might cost less to make lamp bases of aluminum."

"Might cost less, but will the bases be as good?" they asked . . . "Will aluminum change our way of making lamp bases?"

Together we started two long-range projects. One to test aluminum alloys in weather, industrial fumes and years of standing idle that lamps endure. The other to find one of these alloys that could take the punishment of five progressive draws and a thread rolling operation; one with a high melting point to withstand the temperature of the red-hot glass that's poured into bases to insulate them.

Alcoa Research and Alcoa Metallurgy supplied samples. Changed alloys, varied tempers, rolled different thicknesses. The lamp manufacturers tried each in production until one met all requirements. Worked smoothly in high production dies; took a crisp, clean thread; didn't melt or crack at the glassing stage.

Alcoa Process Development Specialists worked long hours to get the right solder and flux to join the side wire connection to the base. Adapted them to the automatic lamp-making machines. Located a manufacturer who would supply production quantities of the special solder wire.

All this time, the lamp manufacturers had aluminum bases installed in seacoast and industrial atmospheres. At our Research Labs we had been testing both lit and unlit lamps under various corrosive conditions. After 3,000 hours of exposure, covering 1½ years, came the report: Aluminum bases measure up to brass in every respect. In corrosion resistance. in conductivity. In ease of installation and removal.

And the cost saving made the change-over decidedly worth while.

Although your problems may have nothing in common with lamp making, Alcoa facilities, experience and specialists in your field are ready to help duplicate the results on a similar long-range program for you, starting now.

ALCOA

there are no limitations on *Imagineering*

for such 1 *Knowledge and Specialists* IN MANY FIELDS

Aircraft
Architectural Specialties
Automotive
- Passenger Cars
- Trucks and Trailers
- Buses
- Parts and Accessories

Bearings
Building Industry
Business Machines
Chemical Equipment
Communications
Corrosion Studies
Diesel Engines
Electrical Conductors
Electrical Equipment
Farm Machinery
Fasteners
Food Equipment
Handling, Packaging and Shipping
Hardware
Heat Exchangers
Home Appliances
Instrumentation
Insulation
Marine Industry
Mining Equipment
Paper Machinery
Petroleum
Pressure Vessels
Printing Machinery
Railroad Equipment
Structural Engineering
Textile Machinery

Among these specialists at the Development Division are men already familiar with the problems of your industry. They are your liaison with the Alcoa research, test and fabricating facilities that can be put to work on your problem. Through them the sum total of Alcoa's knowledge will be brought to bear. Knowledge of practical problems of fabrication and costs, gained in thousands of other projects, will flow toward yours.

DEVELOPMENT DIVISION

long-range projects we have these to offer:

2 FACILITIES FOR BROAD *Research*

Perhaps your project will require only routine Research—like measuring the reflectivity of aluminum sheet shown here. But if you must probe into the basic nature of aluminum—its alloys, strength, chemical and physical properties—Alcoa has the facilities. Facilities which developed most of the aluminum alloys in use today.

3 ADVANCED *Test* EQUIPMENT

Whether you want to check the soundness of your new product by X-Ray or test it under every conceivable service condition, the equipment is here to do it. Years of normal operation can be crammed into hours or days to prove the theories of basic research and test the soundness of designs.

4 *Process Development Shops*
FOR PILOT AND MODEL WORK

After thorough research and testing, the actual fabrication of your project in aluminum may pose further problems. Here Alcoa makes available all the techniques of joining, forming, machining, casting, heat treating and finishing to create a practical pilot model, then suggests low cost, efficient methods for its fabrication.

ALCOA

For more details . . . on the personnel, research and testing, and shop facilities available at Alcoa, write for your copy of the folder, "Road Map to a Better Product." It is your first step toward putting 63 years of aluminum knowledge to work on a long-term project that may effect a major change in your company's competitive position. Address ALUMINUM COMPANY OF AMERICA, 2185J Gulf Bldg., Pittsburgh 19, Pennsylvania.

Aluminum Castings

There's a lot more to the final cost of castings than the price a foundry quotes you.

The price from the foundry is one thing. The final cost . . . machined, handled, assembled into place, and properly finished as part of your completed product can be quite different.

An aluminum casting made by Alcoa might seem to cost a little more than one of another metal as quoted by the foundry. But what machining is needed can be done at speeds impossible with most heavier metals. As a matter of fact, few machine tools can exceed the speeds at which aluminum can be machined.

Aluminum castings can usually be moved quickly by hand. Similar castings of heavy metals would weigh up to three times as much and would usually require hoists. Assembly of aluminum castings is faster . . . painting is frequently eliminated.

Even large aluminum castings can be quickly moved by hand, are easily machined, require no painting in most cases.

And once you've decided on aluminum castings, what about a supplier?

The wrong alloy can affect performance of the part, or add to the cost of casting. A supplier, like Alcoa, experienced in creating aluminum casting alloys, can give you reliable counsel on alloy selection. A supplier, like Alcoa, can get together with your designers on details of design that can have major bearing on final cost and performance. Further, a supplier with Alcoa's flexibility and high capacity can set up delivery schedules that you can depend on . . . that can set a fast pace for your own production line.

Alcoa has casting capacity available to manufacturers with authorized production schedules and metal allotments. Your local Alcoa sales office, listed under "aluminum" in the yellow phone book, will gladly help you.

Aluminum Fasteners

As aluminum is designed into defense equipment, proper selection of rivets becomes increasingly important. Here Alcoa presents facts on Alloys, Tempers and Driving Procedures.

Alloy 2S-F

These rivets are relatively soft, are always driven cold. If maximum softness is desired, 2S-O alloy may be used.

Alloy A17S-T4

Furnished in the heat treated condition and are driven cold as received. Not quite as strong as 17S-T4 rivets, but they eliminate reheat treatment and cold storage necessary on many sizes of 17S-T4 rivets.

Alloy 17S-T4

Usually furnished in heat treated condition. Small sizes may be driven cold. Larger sizes require reheat treatment and cold storage unless driven within a few hours after treatment.

ALCOA

ALUMINUM COMPANY OF AMERICA • 1807K GULF BLDG., PITTSBURGH, PA.

24S-T4

Strongest and most difficult to drive of the aluminum rivets. Generally used only in smaller sizes. They are supplied heat treated, but require reheat and cold storage.

53S-T61

Supplied in heat treated condition and are driven cold as received. They have stable mechanical properties, may be stored indefinitely. 53S-T6 alloy is slightly stronger, but requires more driving pressure.

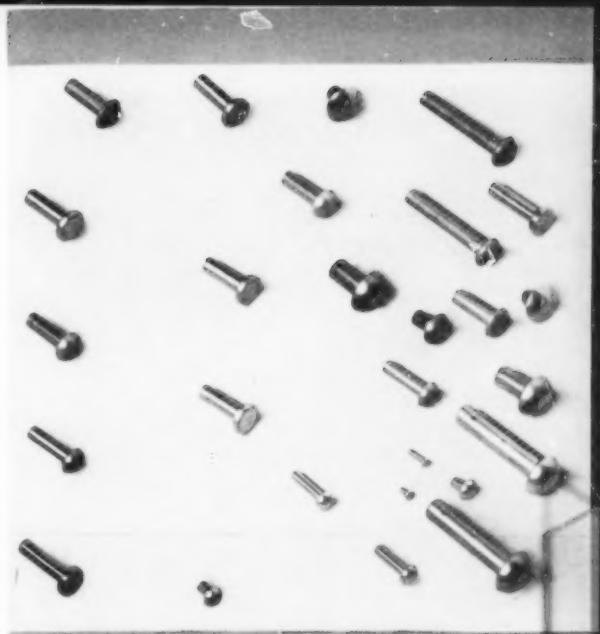
56S-H32

Good strength, good driving characteristics. They are supplied in the cold-worked temper and are driven as received. Used extensively for magnesium work.

Hot Driving

17S-T4 and 43S-T4 alloys may be hot driven in the larger sizes. They are quenched sufficiently by driving immediately upon removal from the furnace. Their properties are developed by natural aging after driving.

Write for the free, 61-page book, "Riveting Alcoa Aluminum"



Alcoa Distributors and Jobbers stock a wide range of rivets in standard alloys and sizes. Special rivets are available on order.

Aluminum Screw Machine Stock

Most design requirements can be satisfied by one of the free-cutting alloys which vary widely in physical and mechanical properties.

Before the cost advantages of Alcoa Screw Machine Stock comes consideration of performance.

What are the strength requirements? Alcoa Screw Machine Stock Alloys range in tensile strength from 42,000 to 62,000 psi. Elongation varies from 10 to 16 per cent in four diameters. Must the part conduct electricity or heat? The free-cutting alloys average between 30 and 40 per cent of the International Annealed Copper Standard on an equal volume basis. They provide thermal conductivity ranging from 0.29 to 0.37 C.G.S. units at 25° C. Their approximate melting temperatures vary between 995 and 1205° F.

Alcoa Alloys resist corrosion by weather, industrial fumes and hundreds of hard to handle chemicals. At sub-zero temperatures they actually *increase* in tensile and yield strengths.

These are but a few of the interesting properties which merit your serious consideration when the free-cutting alloys are again available for unlimited use. Meanwhile, write for a free copy of the 178-page book, "Alcoa Aluminum and Its Alloys."

MECHANICAL PROPERTIES OF THE FREE-CUTTING ALLOYS

ALLOY	THICKNESS INCHES	TENSILE STRENGTH LBS./SQ. IN.	YIELD STRENGTH LBS./SQ. IN.	ELONGATION, % IN 4 DIA., MIN.
11S-T3	0.125 to 1.5	45,000	38,000	10
17S-T4	0.125 to 8.0	55,000	32,000	16
24S-T4	0.125 to 5.5	62,000	40,000	14
61S-T6	0.125 to 8.0	42,000	35,000	10

ALCOA

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Aluminum Extrusions

Almost any shape can be produced by Alcoa. Hollow, semi-hollow, solid . . . any form (within a 15-inch circumscribing circle diameter).

The biggest advantage of aluminum extrusions, made by Alcoa, is that they permit placement of the metal where good design calls for it. Put it where stresses are greatest and where maximum strength is needed, yet save metal as compared to roll forming or fabricating an equivalent section.

To help you visualize the almost limitless possibilities of aluminum extrusions, and to suggest ways in which you can adapt your designs to them, Alcoa has prepared a special booklet that's yours for the asking. Write for it today on your company letterhead. Ask for "Alcoa Aluminum Extruded Shapes."

Here's what the booklet contains:

— a discussion of design and production advantages of aluminum extrusions

— examples of aluminum extrusions that have increased strength and stiffness because of efficient metal distribution

— examples of designs that have been simplified by the use of a single extruded shape to replace expensive built-up assemblies, castings, or machining

— illustrations of the way several extruded shapes can be combined to simplify assembly and reduce costs

— data on size and shape limitations, alloys, section thicknesses, tolerances, die costs

— suggestions on modifying designs to utilize standard shapes for which dies already exist

ALCOA

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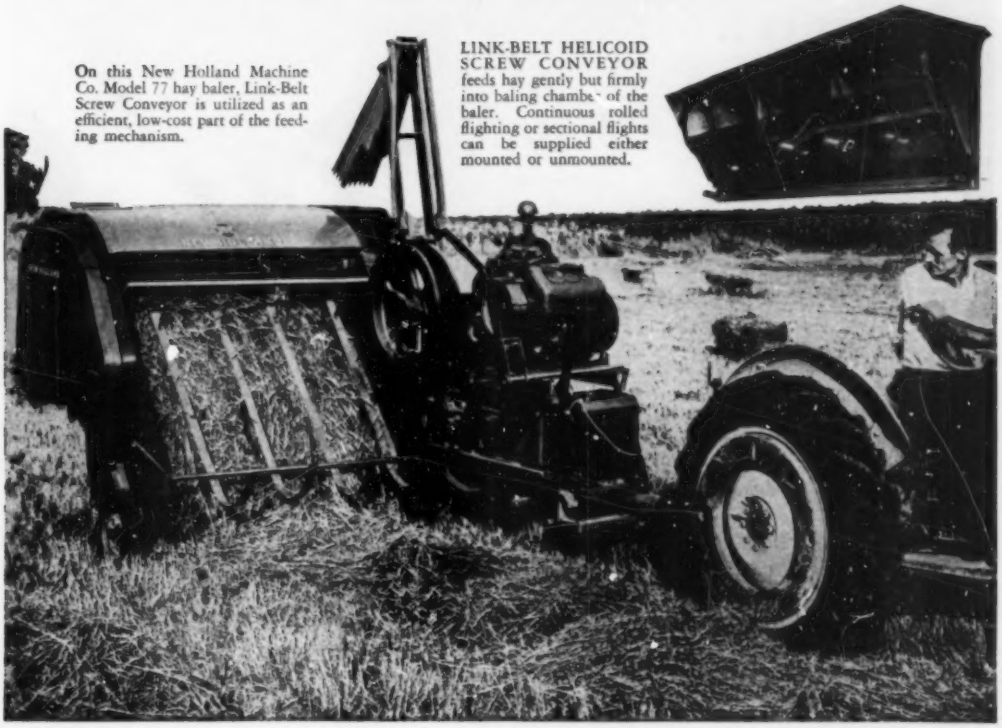
All screw conveyors are not the same...

LINK-BELT offers you the *widest range* of types to match your design needs

On this New Holland Machine Co. Model 77 hay baler, Link-Belt Screw Conveyor is utilized as an efficient, low-cost part of the feeding mechanism.

LINK-BELT HELICOID SCREW CONVEYOR feeds hay gently but firmly into baling chamber of the baler. Continuous rolled flighting or sectional flights can be supplied either mounted or unmounted.



MORE than capacity . . . more than length . . . are considered by Link-Belt engineers when they recommend a screw conveyor for your requirements. Abrasiveness, moisture content, size of feed, corrosiveness and many other factors are important.

Remember, Link-Belt is the nation's top producer of materials handling and power transmission equipment . . . another reason why Link-Belt Screw Conveyors are simple, compact, have few wearing parts, greater dependability. Then too . . . they're accurately made to insure easy assembly and smooth operation.

And you'll find versatile screw conveyors efficiently handling other jobs — elevating, conveying, digging, mixing, spreading, and feeding applications. Get the complete story from the Link-Belt office near you.

LINK-BELT

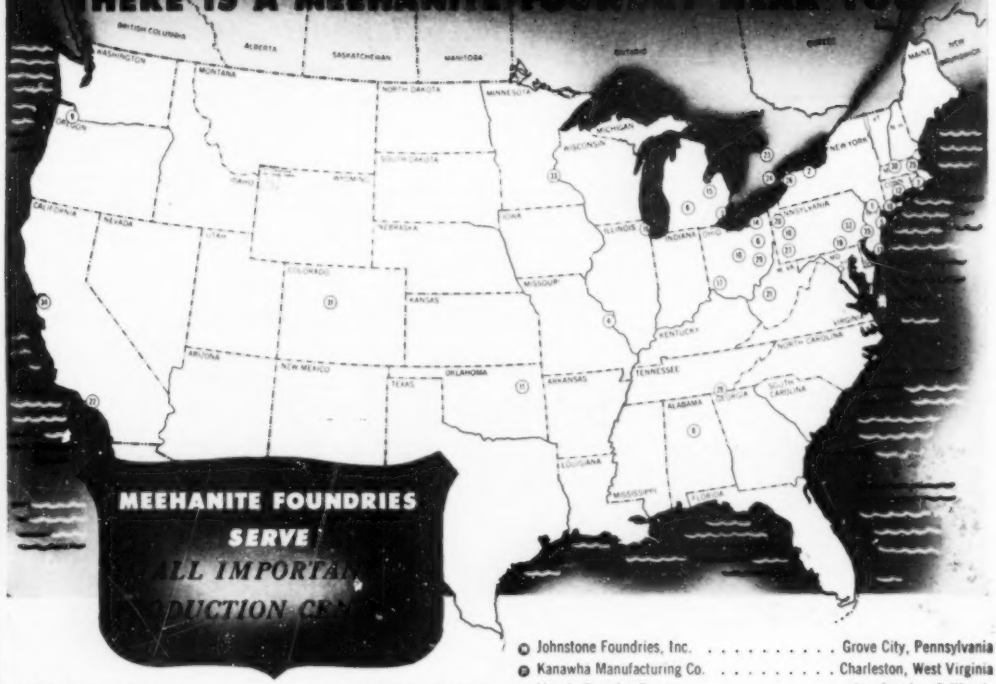
SCREW CONVEYORS

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40 Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa). Offices in principal cities. 13,841

When You Want

QUALITY and SERVICE

THERE IS A MEEHANITE FOUNDRY NEAR YOU



- American Brake Shoe Co. . . . . Mahwah, New Jersey
- The American Laundry Machinery Co. . . . . Rochester, New York
- Atlas Foundry Co. . . . . Detroit, Michigan
- Banner Iron Works . . . . . St. Louis, Missouri
- Barnett Foundry & Machine Co. . . . . Irvington, New Jersey
- E. W. Bliss Co. . . . . Hastings, Mich. and Canton, O.
- Builders Iron Foundry . . . . . Providence, Rhode Island
- Continental Gin Co. . . . . Birmingham, Alabama
- Crawford & Doherty Foundry Co. . . . . Portland, Oregon
- The Cooper-Bessemer Corp. . . . Mt. Vernon, Ohio and Grove City, Pa.
- Empire Pattern & Foundry Co. . . . . Tulsa, Oklahoma
- Farrel-Birmingham Co., Inc. . . . . Ansonia, Connecticut
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- Fulton Foundry & Machine Co., Inc. . . . . Cleveland, Ohio
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- Greenlee Foundry Co. . . . . Chicago, Illinois
- The Hamilton Foundry & Machine Co. . . . . Hamilton, Ohio
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- Ross-Meehan Foundries . . . . . Chattanooga, Tennessee
- Shenango-Penn Mold Co. . . . . Dover, Ohio
- Standard Foundry Co. . . . . Worcester, Massachusetts
- The Stearns-Roger Manufacturing Co. . . . . Denver, Colorado
- Traylor Engineering & Mfg. Co. . . . . Allentown, Pennsylvania
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- Vulcan Foundry Co. . . . . Oakland, California
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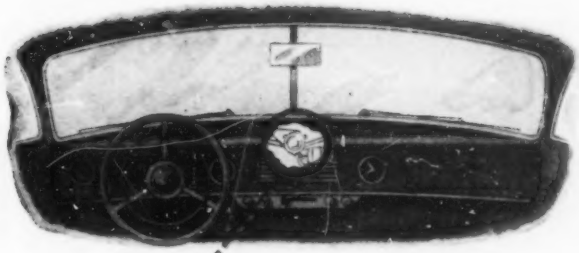
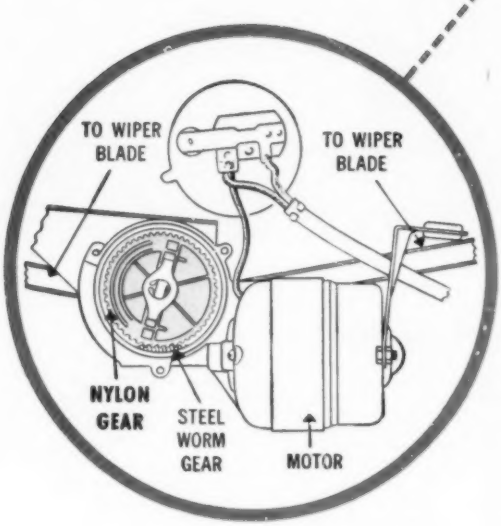
MEEHANITE ®

New Rochelle, N.Y.

"This advertisement sponsored by foundries listed above."



Wiper gear molded of Du Pont NYLON



Nylon gear, 2¼" in diameter, is molded for Redmond Co., Inc., Owosso, Mich., by Perry Plastics, Inc., Erie, Pa.

gives outstanding performance, costs ½ as much as machined gears

When this new electric windshield wiper was in the design stage, Redmond Company engineers tested conventional machined gears and gears injection-molded of Du Pont nylon. Not only was it found that nylon gears gave excellent performance, but they cost about half as much as machined gears, because of the economies of rapid, mass-production injection-molding. For the complete nylon gear is molded in one piece . . . no machining needed for gear teeth, the slots which transmit power to wiper blades, or the "parking ramp" that returns blades to lower edge of windshield when power is switched off.

It's another case of performance and economy for Du Pont nylon as an engineering material. Nylon has the strength and resiliency this gear needs. In case the wiper blades freeze to the windshield, the nylon gear can take the full thrust of the motor.

Heat-resistance is also necessary. Since the nylon gear performs satisfactorily at 200°F., its heat-resistance is more than adequate to do the job. Further, nylon has outstanding abrasion-resistance, and requires a minimum of lubrication.

Demand for nylon currently exceeds supply. However, we suggest you investigate the properties of nylon for future application. We will gladly discuss the availability of quantities for development work. For additional information on nylon and other Du Pont plastics write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department, District Offices:
350 Fifth Avenue, New York 1, New York
7 South Dearborn Street, Chicago 3, Ill.
845 East 60th Street, Los Angeles 1, California

DU PONT
BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY
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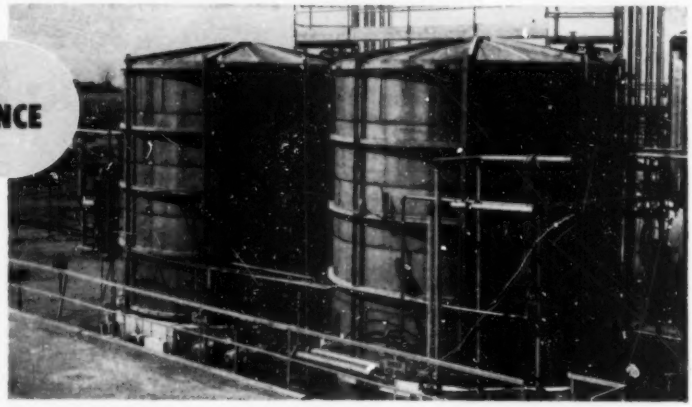
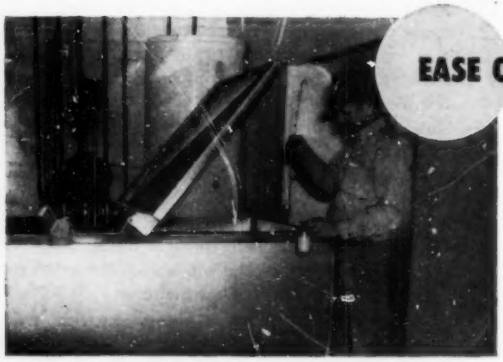
PLASTICS • CHEMICALS

Only Stainless

CORROSION RESISTANCE

U·S·S Stainless Steels have demonstrated their resistance to many types of corrosion. The storage tanks shown here, for example, hold highly-corrosive 55-60% concentrations of nitric acid; yet they are fabricated from Stainless sheets only one-tenth of an inch thick.



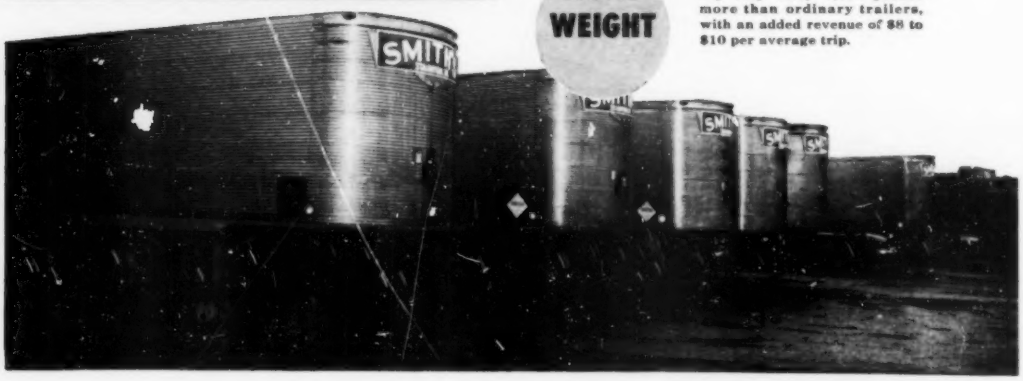


EASE OF CLEANING

Because U·S·S Stainless Steel is so easy to clean and easy to keep clean, it is in a class by itself for milk handling equipment. Now its use is being extended to the farm, where Stainless cooling and holding tanks permit bulk milk to be picked up at the farm by Stainless tank trucks.

STRENGTH WITH LIGHT WEIGHT

Trailers of U·S·S Stainless Steel provide a graphic example of the savings in weight without sacrifice of strength that this type of construction makes possible. Owners of these trailers say they carry 1,200 pounds more than ordinary trailers, with an added revenue of $8 to $10 per average trip.



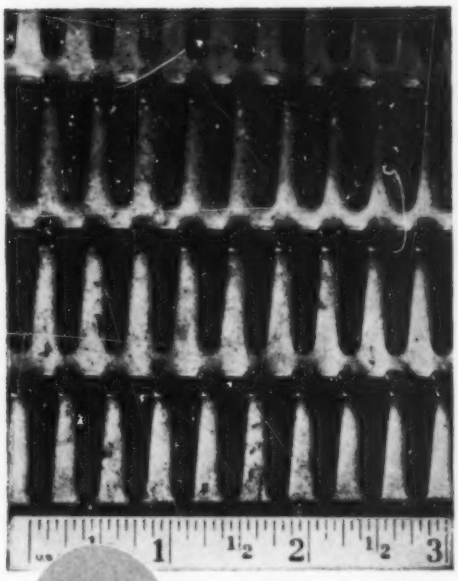
Steel

gives you this combination of advantages

● No other group of metals combines so many cost-cutting benefits as you'll find in the family of Stainless Steels. Any one of these advantages will usually offset the sometimes higher first cost of Stainless . . . the other desirable properties are then a bonus for the user.

You can obtain these money-saving advantages of Stainless at their best in U·S·S Stainless Steel. Here you have perfected, service-tested steels, manufactured in the widest range of grades, forms, sizes and finishes.

Defense requirements have restricted the supply of some grades of U·S·S Stainless Steel today. But our Stainless engineers will be glad to assist you in attempting to fit available steels to your particular design problems. Ask for their assistance.



LONG LIFE

The dense, durable surface of U·S·S Stainless Steel, combined with its superior resistance to corrosion, heat and abrasion, makes it a good bet to outlast other materials under the most severe service conditions. This Stainless Steel screen—used for sizing and dewatering wet coal—is shown here after handling 805,000 tons of coal over a two-year period. Carbon steel screens were worn out after 150,000 tons.

FREEDOM FROM CONTAMINATION

Stainless Steel has no contaminating effect on most products that come in contact with it. This property is especially important in equipment like these vats for soaking silk fibre. Owners of the throwing mill where this equipment is installed say that the use of Stainless Steel has eliminated rejects due to rust contamination.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM · UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S STAINLESS STEEL

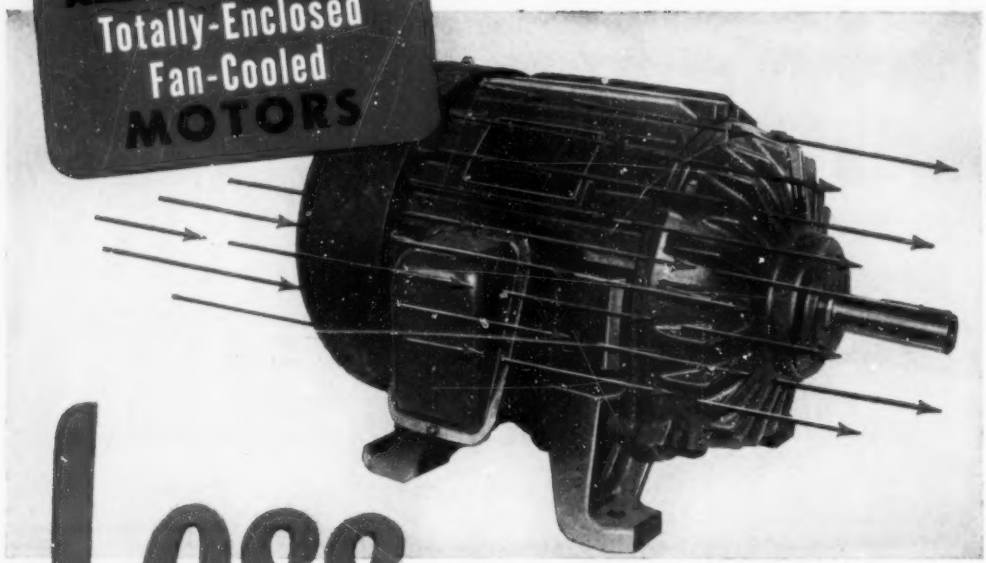
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

1-1380

UNITED STATES STEEL

ALLIS-CHALMERS

Totally-Enclosed Fan-Cooled MOTORS



Less MOTOR CLEANING ...INSPECTION...OVERHAUL!

HERE'S A MOTOR that actually blows itself clean! Dirt is carried away by cooling air blown over the ribbed cast iron frame and bearing housings of this new Allis-Chalmers tefc motor.

Dirt can't build up to cause overheating. Concealed air passages and pockets have been eliminated. Even oily dirt that sticks can simply be wiped or blown off.

And this means savings! Maintenance costs are traditionally low on totally-enclosed, fan-cooled motors. But they're lower than ever before on the new Allis-Chalmers Type APZ tefc motor.

Rigid Construction

The frame is cast iron which has high resistance against corrosion and distortion. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

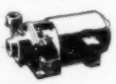
The new Allis-Chalmers Type APZ totally-enclosed, fan-cooled motor is built in all NEMA standard frame sizes from 224* to 505. Also in explosion-proof type. Your A-C Authorized Distributor or District Office has complete information. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225. A-3426

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.



PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

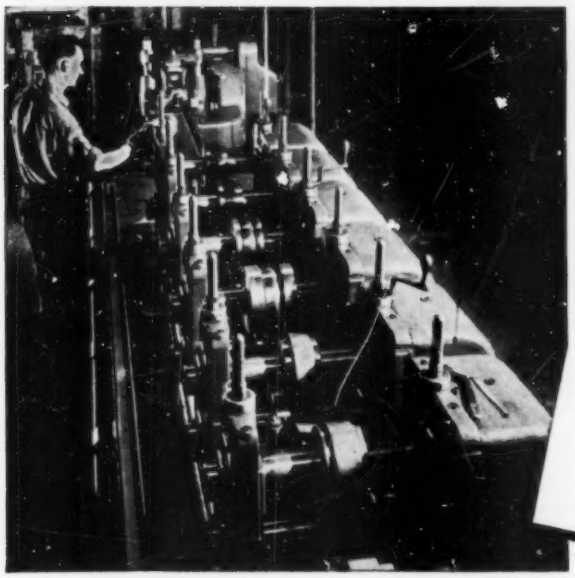
Texrope and Vari-Pitch are Allis-Chalmers trademarks.

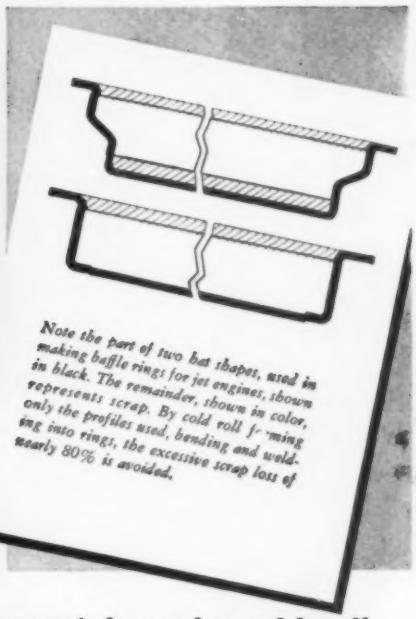
ALLIS-CHALMERS

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

12 EXAMPLES OF ECONOMIES

effected by combining different operations in a YODER Roll Forming Machine





Note the part of two hat shapes, used in making baffle rings for jet engines, shown in black. The remainder, shown in color, represents scrap. By cold roll forming only the profiles used, bending and welding into rings, the excessive scrap loss of nearly 80% is avoided.

No. 12. Up to 80% saving in material cost by cold-roll forming, avoiding former heavy scrap loss

Of all the methods available for cold-shaping flat rolled metal, the cold roll forming machine offers the highest production per man hour and the lowest conversion cost. It is often a good investment even when operated only a few days per month.

Of still greater importance than conversion cost is often the saving of weight which may be effected by designing light, strong box, tubular and other special structurals to take the place of hot rolled angles, channels, tees, etc. Material savings up to 50% are frequently made.

In press forming of hat shapes to make stator rings for jet engines, up to 80% of the metal has to be cut away and discarded in order to obtain one ring. By cold roll forming the profile from strip, cutting to length, bending into rings and joining ends by welding, this huge scrap loss is avoided. Here is another example of how a Yoder cold Roll Forming production line may save scarce and expensive stainless steel, aluminum, brass and other metals. In such cases, the material savings alone may be many times greater than the conversion cost, even for relatively small quantities.

Function, scope, and economics as well as mechanics of cold roll forming, are discussed in Yoder's 86-page illustrated book which will be sent on request. Recommendations and estimates for the asking.

THE YODER COMPANY • 5522 Walworth Avenue, Cleveland 2, Ohio, U. S. A.

Complete Production Lines

- ★ COLD-ROLL-FORMING and auxiliary machinery
- ★ GANG SLITTING LINES for Coils and Sheets
- ★ PIPE and TUBE MILLS—cold forming and welding

ENGINEERING YODER MANUFACTURING

Life-Linestarter
PAIRED FOR PRODUCTION
Life-Line motor
WESTINGHOUSE
WESTINGHOUSE
DO NOT LUBRICATE

Insure

machine performance with this matched pair

Motors and controls can make or break the performance of your machine tools. Why speculate? Life-Lines assure peak performance under all conditions. Take these, for example:

Accidental blows to starters? Will false operations result? Not with the Life-Linestarter®. Its inverted clapper-type design provides positive operation.

Contact life? Life-Linestarter contacts last longer, why? Because the exclusive "De-ion"® arc quickly divides, confines, and extinguishes the arc. Contacts, therefore never need filing.

Bearing lubrication? Life-Line motors prelubricated, sealed-for-life bearings eliminate this problem. These bearings need no lubrication. And because they are sealed, there's less chance for grit and dust to harm the bearings.

Physical abuse? Falling objects, excessive vibration, corrosive atmospheres—all take a heavy toll of weak motor frames. Thousands of installations have proved that Life-Line's steel frame stands up to physical and chemical abuse better than conventional frames. Steel adds strength without additional weight.

Consider the many other features of this motor and control production team—"paired for performance." Your Westinghouse representative has the facts. Ask him for copies of "Life-Line Motor Book" B-3842 and "Tomorrow's Starter Today" B-4677. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30. Pa.

J-21638

YOU CAN BE SURE.. IF IT'S

Westinghouse

Life-Line

MOTORS and CONTROLS

PROBLEM:

... to Get "Aluminum-to-Aluminum" Connections in ... Termination of Aluminum Conductors

GENERAL PLATE:

Provided the Solution with the Composite Metal **ALCUPLATE***

Aircraft manufacturers and power companies were troubled with the electrolytic action which took place when aluminum main line cables were joined to copper branch lines. To overcome this problem it was necessary to have aluminum-to-aluminum or copper-to-copper connections.

General Plate engineers solved the problem with *Alcuplate* (aluminum clad to copper) which gives like metal connections, thus overcoming the corrosion objections. Alcuplate is widely used in the electrical field for clips, shims, bushings, terminals, etc. Enclosures for sealed devices can be spun or drawn from *Alcuplate* and the copper surface makes soft soldering easy.

Alcuplate is available in sheet, strip or seamless tubing.

No matter what your metal problem, it will pay you to consult with General Plate. Their vast experience in cladding precious to base metals or base to base metals can overcome your problems . . . often reduce costs.

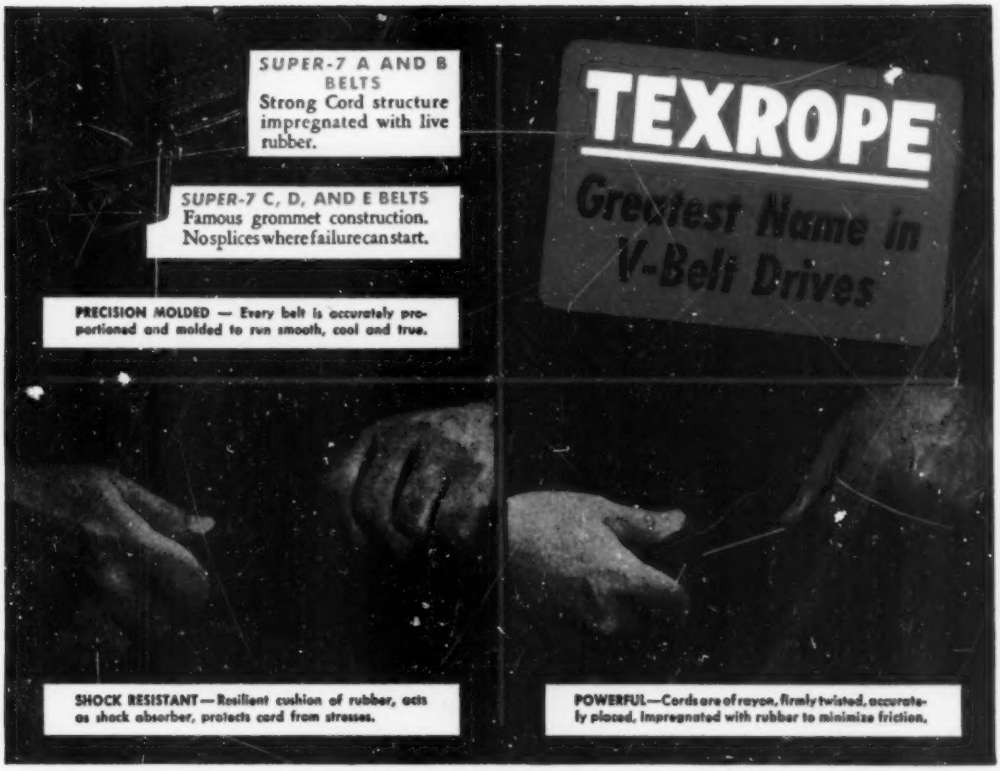
General Plate Products include . . . Precious metals clad to base metals, Base metals clad to base metals, Silver Solders, Composite contacts, buttons and rivets, Platinum fabrication and refining, Age-hardenable #720 Manganese Alloy. Write for information. *Reg. U. S. Pat. Of.

Have You a Composite Metal Problem? General Plate can solve it for you

GENERAL PLATE

Division of Metals & Controls Corporation

110 FOREST STREET, ATTLEBORO, MASS.


SUPER-7 A AND B BELTS
Strong Cord structure impregnated with live rubber.
SUPER-7 C, D, AND E BELTS
Famous grommet construction. No splices where failure can start.
PRECISION MOLDED — Every belt is accurately proportioned and molded to run smooth, cool and true.
TEXROPE
Greatest Name in V-Belt Drives
SHOCK RESISTANT — Resilient cushion of rubber, acts as shock absorber, protects cord from stresses.
POWERFUL — Cords are of rayon, firmly twisted, accurately placed, impregnated with rubber to minimize friction.

Cool Running... LONG LIVED!

SUPER-7 V-belts give long, satisfactory service even under bad conditions of load, shock and grit.

Tough, double-wrapped cover bias cut for elasticity and impregnated with rubber. Effectively seals out dust, grit, moisture; takes the wear; keeps the belt in shape; and protects cord structure.

But you get more than good belts when you standardize on *Super-7* V-belts. You also get the benefit of the greatest V-belt experience in the world both in the field and factory. You are assured of exactly the right drive for longest life from the wide variety of types and sizes available.

High Capacity Belts

Where space is limited or other special conditions demand heavier duty, the high capacity belt can be furnished in A, B, C, D, and E sections . . . Extra strong cords, special rubber cushion and tough Neoprene cover give them 40% greater capacity than standard belts at proportionately higher price.

V-Belt Drive Headquarters

Your nearby Allis-Chalmers Authorized Dealer or Sales Office can serve all your V-belt needs, whether they be new or replacement V-belts; standard and variable speed sheaves; or speed changers.

Get your copy of the revised 120 page *Texrope* Pre-Engineered Drive Manual from your A-C Dealer or Sales Office or write for Booklet 20B6956A. Allis-Chalmers, Milwaukee 1, Wisconsin.

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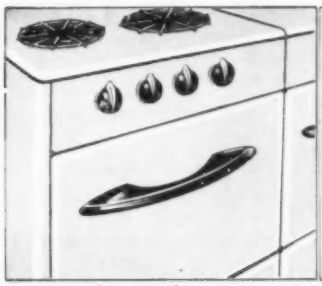
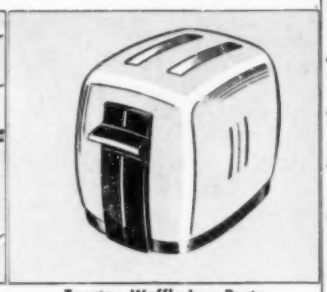
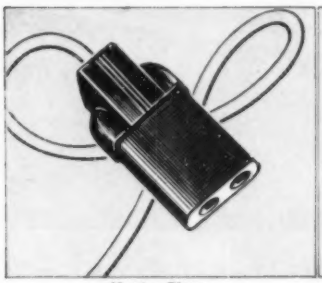


Stove Hardware

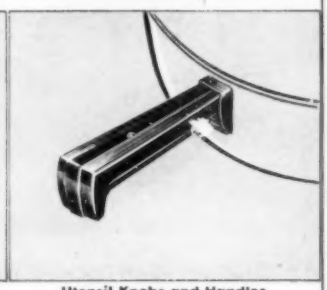


Toaster, Waffle Iron Parts

Ignition Parts



Heater Plugs



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Many products and parts that operate at high temperatures are designed with *heat-resistant* BAKELITE Phenolic Plastics in mind. An extensive group of such materials meets recurrent temperatures ranging from 375 to 525 deg. F. In addition, these mineral-filled molding plastics as a class are the most dimensionally stable of all the phenolics, primarily because of their very low moisture absorption.

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Phenolic PLASTICS

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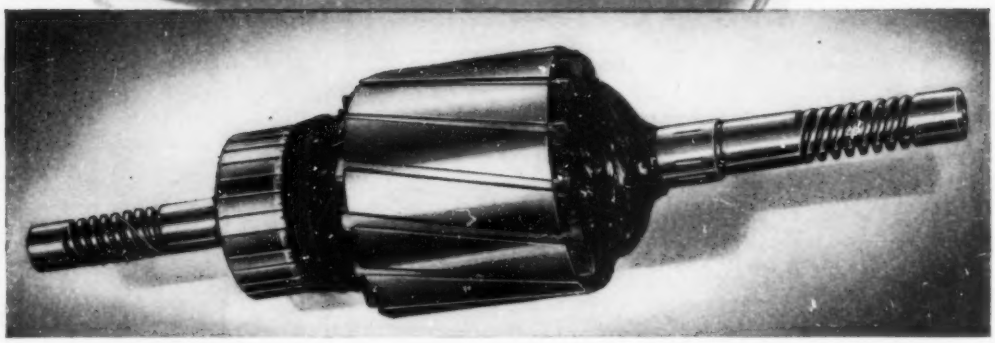

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These are only a few of the many advantages of plastics.

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"We scrapped HABIT-ITIS* for "sample-size" packages of Vuepak . . . and sell pharmaceuticals better, faster, at low cost" —says R. E. Hodgkin, sales Vice-President, Ayerst, McKenna & Harrison, Ltd., New York. Packages above—fabricated by Plastic Artisans, Inc., White Plains, N. Y.

*habit-thinking in design and materials engineering

In sight, in mind . . . in plastics

Manufacturers in many another industry might profitably ponder the sales-success of pharmaceutical houses like Ayerst. Here, management has wiped clear the cobwebs of habit-thinking . . . has discarded old-time materials for new *visual* packages of plastics.

Packages like these—made of Monsanto's Vuepak, cellulose acetate—make selling easier. Help customers "reach for your product" faster. Sparkling, crystal-clear Vuepak is light in weight, yet sturdy.

Vuepak's sales-pulling power is *proved*. So is its low cost per unit.

Vuepak is but one of the big Monsanto family of plastics suitable for fabricated or molded packaging. It'll pay you to investigate them. Just send for Monsanto's idea-booklet, "Package in Plastics." Write to the MONSANTO CHEMICAL COMPANY, Plastics Division, Room Springfield 2, Mass.

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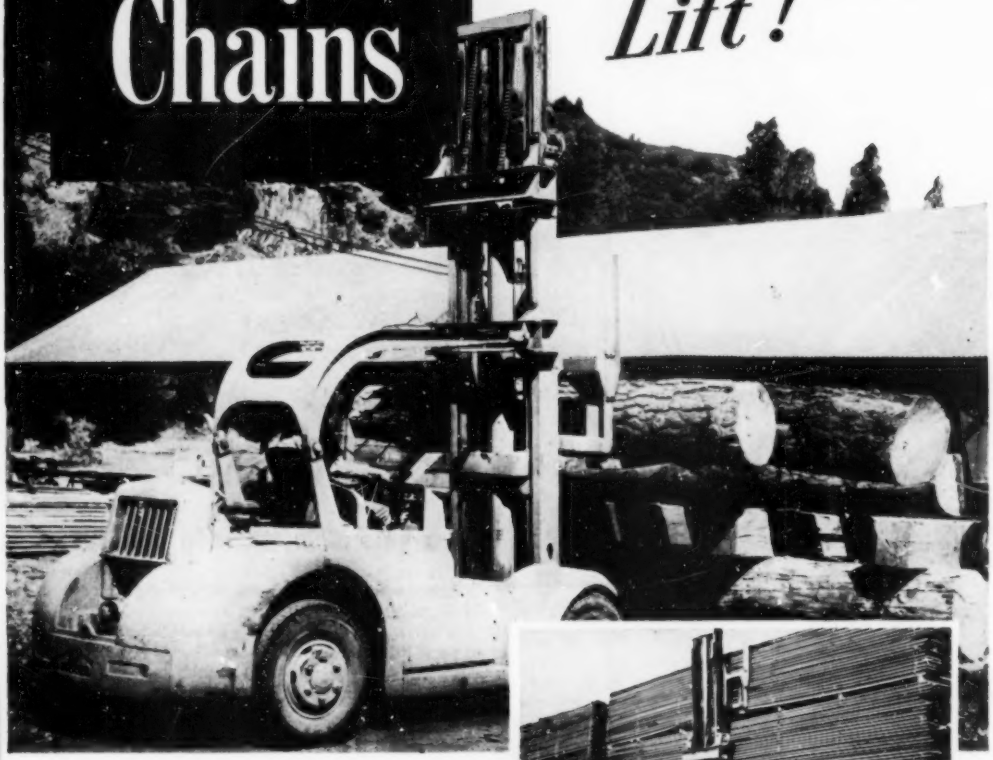

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AMERFINE—*High-quality fine wire.*

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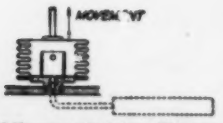

Fig. 1 Thermostatic Motor—This type of assembly is widely used in temperature regulators, etc., where a thermostatic charge is confined in the bellows and where a valve, switch, damper, etc. is to be operated in response to temperature changes.

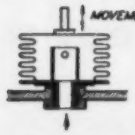

Fig. 3 Pressure Motor—Bellows assemblies are often employed to convert pressure effects into controlled movement. Fig. 3 shows such an assembly where the pressure is applied inside the bellows.

Fig. 5 Expansion Chamber—This type of assembly is employed to absorb thermal or pressure expansion. With suitable heads, it would be used to serve as a reservoir for a liquid or gas. Example: Oil reservoir for electrical cable joint.

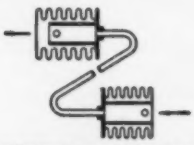

Fig. 7 Motion Transmission—Two bellows assemblies joined by a tube for hydraulic transmission of motion or power. Motive force applied may be either thermostatic or mechanical.

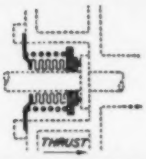

Fig. 9 Shaft Seal—Widely used for refrigeration compressors to prevent leakage around revolving shaft. Spring pressure holds nose of seal against shoulder on shaft. Another type used rotates with shaft and seals against stationary plate.

• It seems like magic—the ways that Sylphon and Bridgeport bellows assemblies help solve design problems involving control of temperatures or pressures. The diagrams pictured here are typical—show you "how it's done."

And "doing it" is our specialty—has been for half a century. We've developed bellows assemblies that are used in practically every industry. They open and close valves, dampers, etc., absorb expansion, provide packless construction—have many more uses.

Whatever your bellows assemblies requirement may be, you can get expert help from us. You may have a problem similar to one we have solved for another customer. Or, you may need assistance in developing an assembly for a specific application. Let's talk it over.

Skilled craftsmen and complete production facilities assure bellows assemblies made *exactly* for *you*—that make important savings for you in time, trouble and money. Wide range of metals and sizes. Write for information. Ask for idea-filled Catalog TP-1200.

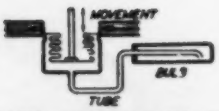

Fig. 2 Thermostatic Motor—This assembly is used where it is desirable to have the thermostatic charge confined outside the bellows and within a cup. May be used with or without remote bulb shown.

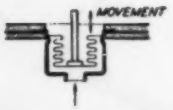

Fig. 4 Pressure Motor—This assembly differs from Fig. 3 in that the pressure is applied outside the bellows and within a cup.

Fig. 6 Expansion Joint—Packless and leakless construction for expansion joints used to absorb thermal expansion of pipe lines carrying steam, water, etc. May be used to absorb vibration and provide flexible connection for other applications.

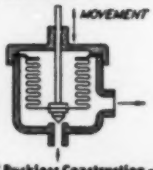

Fig. 8 Packless Construction—Illustrating packless valve construction. Same principle used to seal stem movement or adjustment in many types of apparatus.

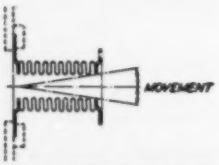

Fig. 10 Flexible Joint—Providing a means to seal a flexible joint or mechanical movement of levers, linkage, etc., against leakage where the movement must be conveyed outside an enclosure. Example: Operating stem of float switches, etc.

TEMPERATURE CONTROLS

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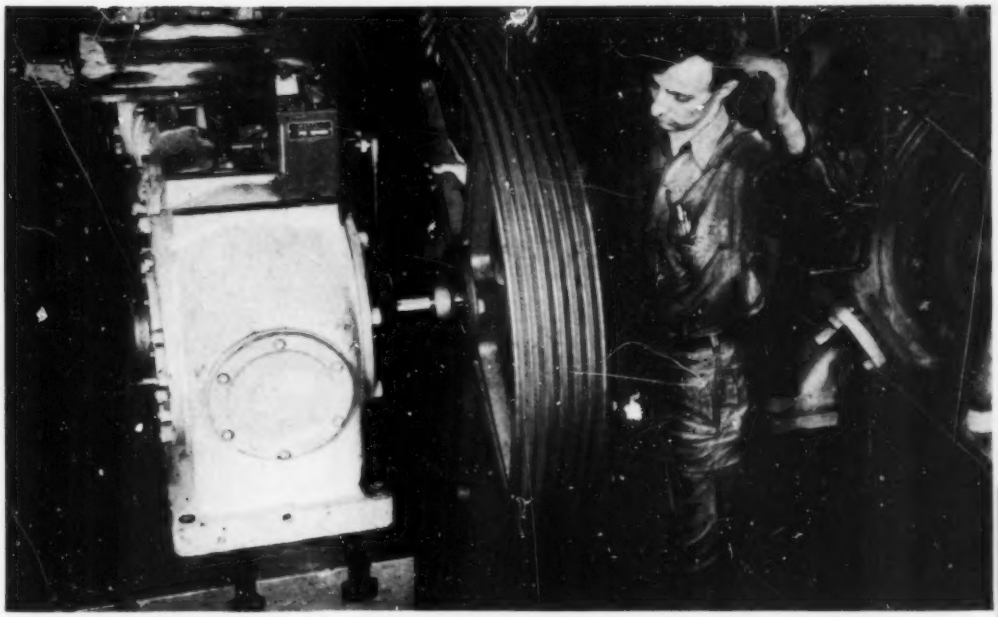

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which all industry likes best

QD
TRADE MARK Pat. No. 2259821

Split hub is clamped to shaft. Heavier taper-bored rim slides easily over tapered hub—no keyway obstruction on cone surface. Positive press fit on shaft. Large, long pull-up bolts also used as jack screws to remove rim.

Here's a 26-word description of the V-belt sheave that is used more than any other.*

Two parts for easy handling—separately or together. Split hub and taper-mated rim make mounting easy. No realignment problem—clamped hub stays put while changing rims.

That's Worthington's QD—the original tapered cone-grip sheave that's preferred by men who have to install or change sheaves. The QD is *easy to get on, easy to get off, yet always tight on the shaft*—tighter than any other sheave on the market. Hubs for every bore—lower inventory cost.

For your machines, pick Worthington Multi-V-Drives with QD sheaves and Worthington-Goodyear EC Cord V-belts.

Worthington's complete line also includes FHP drives—QD Junior (quick-detachable) V-pulleys and many other styles.

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MV.1.8

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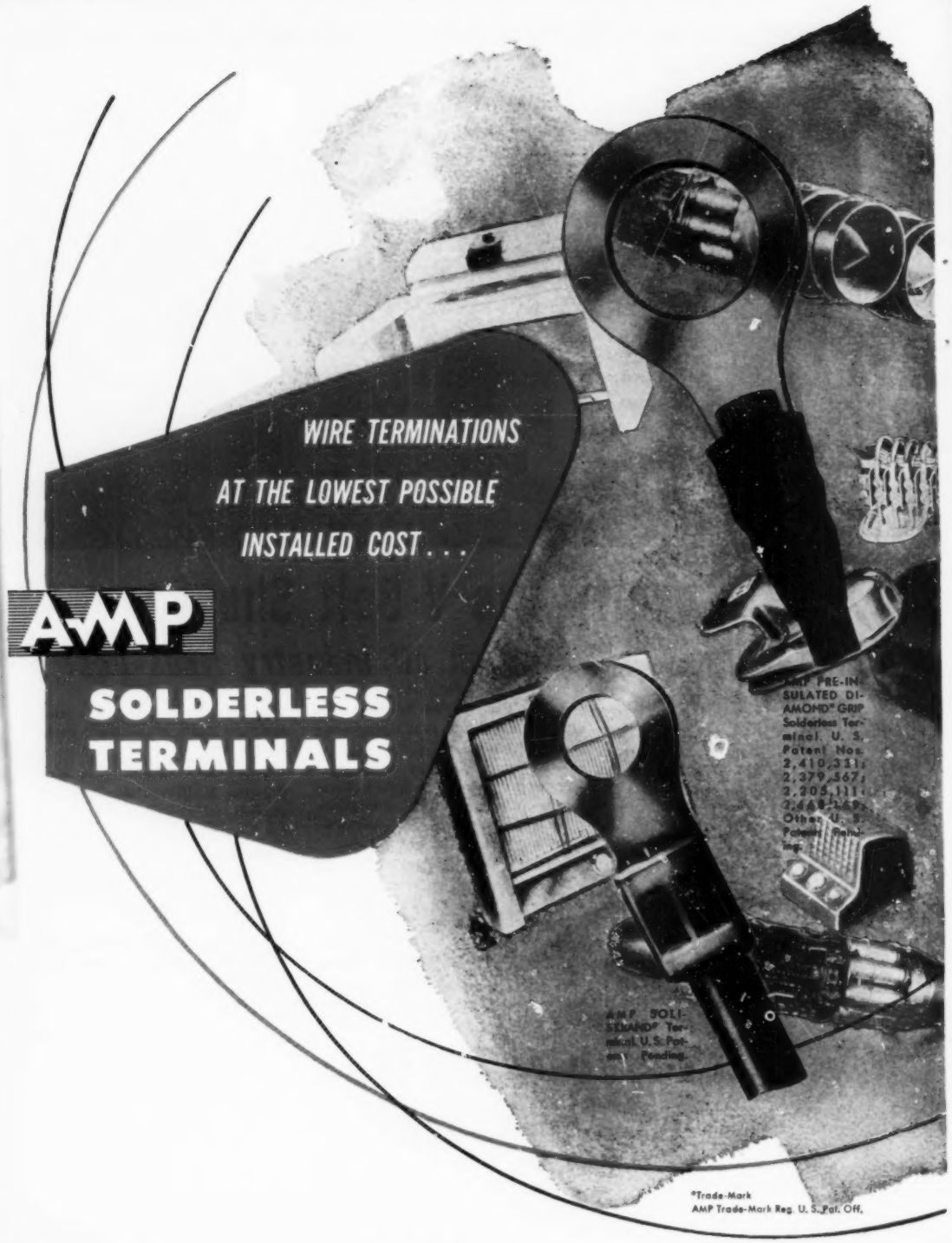
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AT THE LOWEST POSSIBLE
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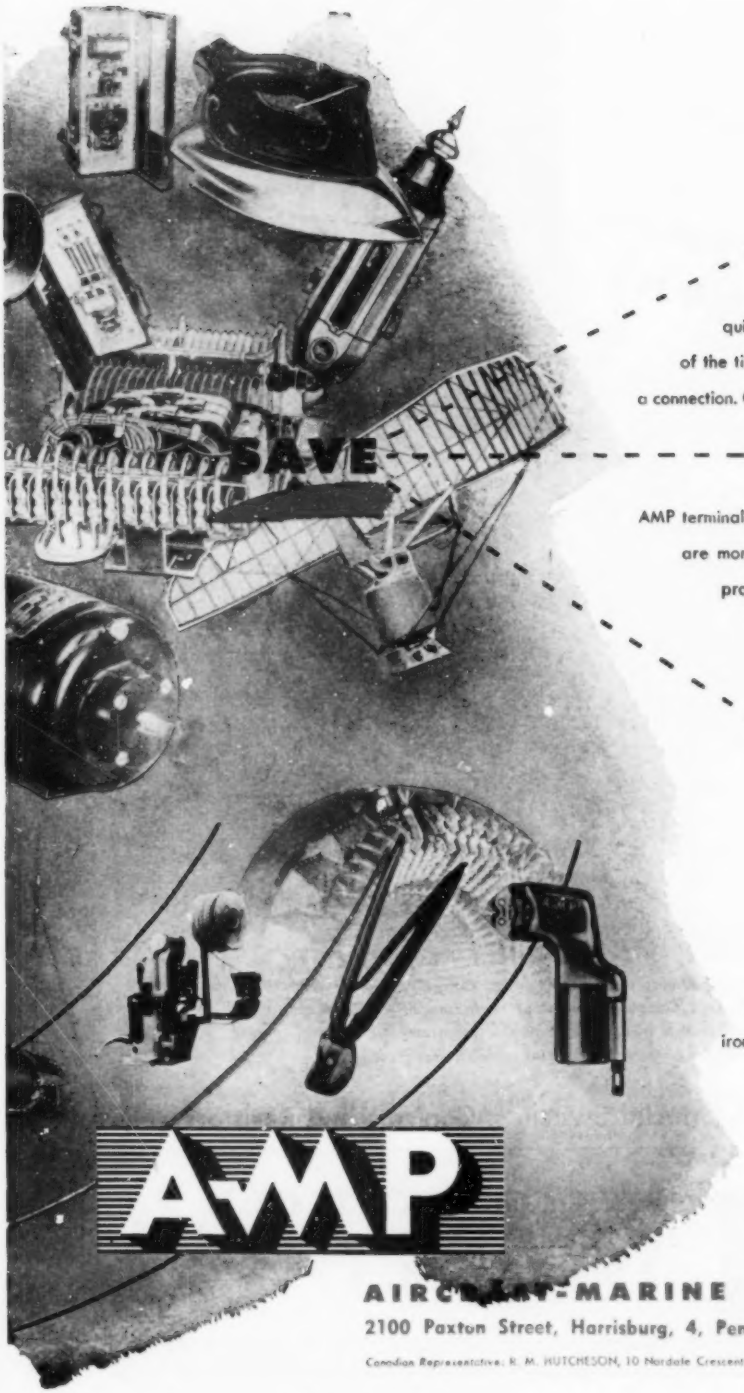

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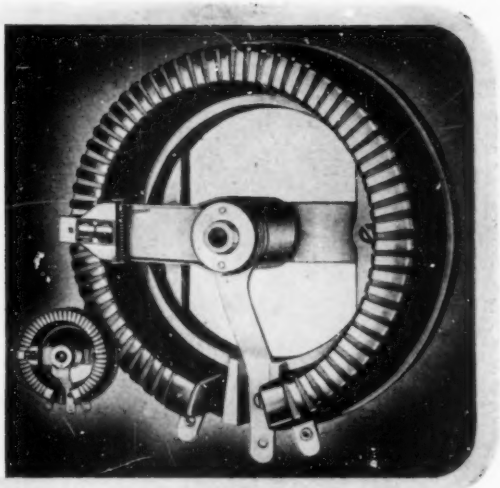
A Line of Power Rheostats From MALLORY



Another precision product has been added to the line of electric, electronic and metallurgical components produced by Mallory. Designated as Mallory Type "K" Rheostats, these units are available in seven different sizes, from 50 to 500 watts and in a wide range of resistance values.

A special feature of the Type "K" Rheostat is the assurance of long life and dependable service. A patented, hinged, spring contact arm provides smooth and easy operation, correct and constant pressure, and easy accessibility for cleaning or inspection. This construction prevents high contact resistance and overheating which might otherwise result from lifting the contact arm to examine or clean the block.

Other important construction details include uniform winding, permanent sealing with porcelain vitreous enamel, rigidity through the use of dimensionally-stable ceramic parts for insulation of all current-carrying sections.

Mallory Type "K" Rheostats are available with tapered windings and tandem construction, on special order.

The Mallory Power Rheostat is the same design formerly manufactured by the Rex Rheostat Company. Numerous variations of the standard unit can be produced to meet your particular requirements. A technical bulletin containing descriptive data is available on request.

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Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set-screws in spring locking collar.
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CUTAWAY OF SERIES 200 BALL BEARING FLANGED BLOCK.
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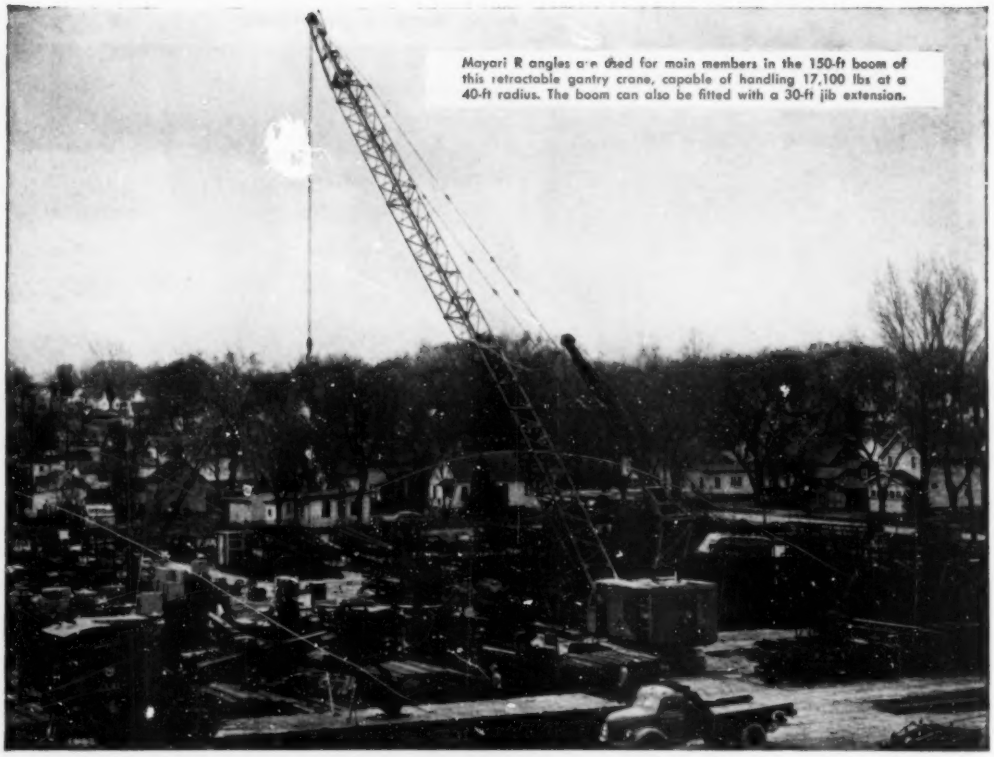

Mayari R angles are used for main members in the 150-ft boom of this retractable gantry crane, capable of handling 17,100 lbs at a 40-ft radius. The boom can also be fitted with a 30-ft jib extension.

Boom made of MAYARI R 30 ft longer and 2000 lbs lighter

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Solution: After they studied the mechanical properties of various grades of steel the engineers concluded that Bethlehem's Mayari R would do the job at low cost. The main longitudinal members were made of Mayari R angles of thinner gage than ordinarily used with structural-grade carbon steel. This reduced the deadweight and at the same time provided the extra strength needed for the longer structure. Because of the reduction in weight made possible with Mayari R, the crane has a lifting capacity 1000 lbs greater than with the previous booms.

If you are building construction equipment of any type, it will pay you to look into the advantages of low-alloy, high-strength Mayari R. It goes farther than ordinary steel, and it allows worthwhile improvements in design. Write for a copy of Mayari R catalog 259.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

★ BETHLEHEM STEEL ★

Mayari R *makes it lighter... stronger... longer lasting*

SAFTIFILTER*, all-plastic blood and plasma infusion set made by Cutter Laboratories, Berkeley, Calif.

the important Barrel is... MADE OF

STYRON

chosen because of

heat resistance

•

moisture resistance

•

dimensional stability

•

moldability

Styron (Dow polystyrene) here serves dramatically in the hospital field. A deep draw over a precisely dimensioned core dictated Styron for the barrel of this blood and plasma infusion set. Styron has the moldability and dimensional stability so necessary to fabricate precision components. Uniform quality and maintenance of precise dimensions in service were assured by annealing the barrel made of Styron.

In the manufacture of this essential product, and many others, the range of Styron's properties offers engineers and designers the advantages of more design freedom, quality product appearance and reduction in assembly steps and production costs—all of significance to manufacturing industries.

Dow offers a complete line of quality-controlled polystyrene plastics under the trade-mark name Styron. Dow's Plastics Technical Service is fully equipped to advise you on the applicability of Styron to *your* manufacturing operations. Write today.

THE DOW CHEMICAL COMPANY
Plastics Division—Dept. PL-82
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington
Atlanta • Cleveland • Detroit • Chicago • St. Louis
Houston • San Francisco • Los Angeles • Seattle
Dow Chemical of Canada, Limited, Toronto, Canada

**Trade mark property of Cutter Laboratories*

The Styron label is the hallmark of quality in plastics goods.

DOW plastics

STYRON *brand plastics*

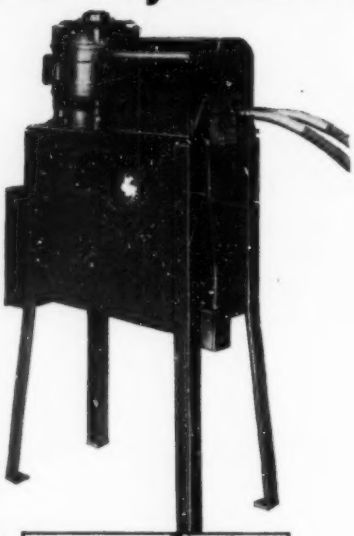
. . . basic raw materials serving basic industries

IF YOU RIVET PUNCH FORM BEND...*Investigate* "HY-POWER" Hydraulics

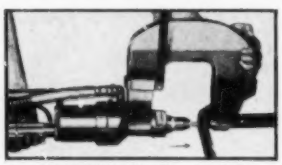
What is "Hy-Power"? The "heart" of the "Hy-Power" hydraulic system is the unique "Hy-Power" Generator—a combination of motor, pump, oil reservoir, control valves and high pressure intensifier assembled as a compact, self-contained unit—an exclusive, highly useful Hannifin development.

What will it do for you? This "Hy-Power" Generator, operating Hannifin work tools with instantly reversible push-button control, gives you "Hy-Power" Hydraulics; enables you to rivet . . . punch . . . form or bend with forces up to 100 tons (more with multiple cylinders). Everywhere, engineers are turning to this modern hydraulic power source for cost-reducing production.

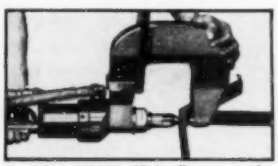
No doubt *you* can profit through Hannifin's wide experience with "Hy-Power" Hydraulics and practical recommendations for its use in your plant! Hannifin Corporation, 1125 S. Kilbourn Ave., Chicago 24, Ill.



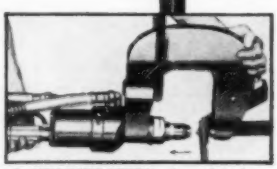
DESIGN ENGINEERS AND TOOLING SPECIALISTS...PUT THIS FINGER-TIP CONTROLLED WORK CYCLE TO WORK FOR YOU!



A. FAST APPROACH—Pressing button (finger-tip control) moves ram up to work at fast speed, using primary hydraulic pressure. *Ram returns instantly to starting position any time button is released.*



B. WORK STROKE—Hydraulic pressure is automatically intensified, and the riveting, punching, forming, bending is completed.

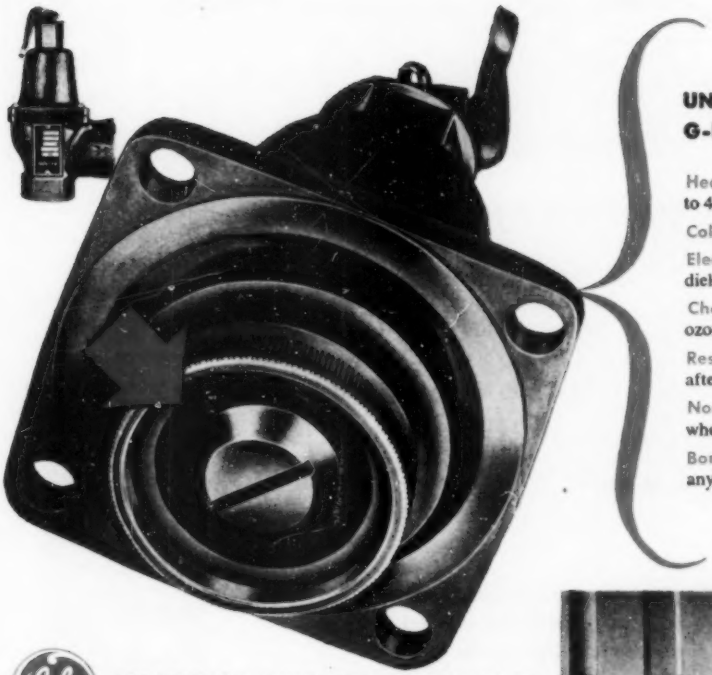


C. AUTOMATIC RETURN—At peak hydraulic pressure (adjustable), the ram reverses automatically; returns to starting position.

do ALL you CAN do...with

HANNIFIN

Air Cylinders • Hydraulic Cylinders • Hydraulic Presses • Pneumatic Presses • "Hy-Power" Units • Air Control Valves



UNUSUAL PROPERTIES OF G-E SILICONE RUBBER

Heat—withstands continuous exposure to 450 F —500 F for short periods.

Cold—flexible at —85 F.

Electrical—excellent insulator; high dielectric strength.

Chemical—resists moisture, oxidation, ozone, sun, fungus, oils, chemicals.

Resilience—low-compression set—even after exposure to high heat.

Non-Sticking—doesn't become tacky when heated. Won't stick to metal.

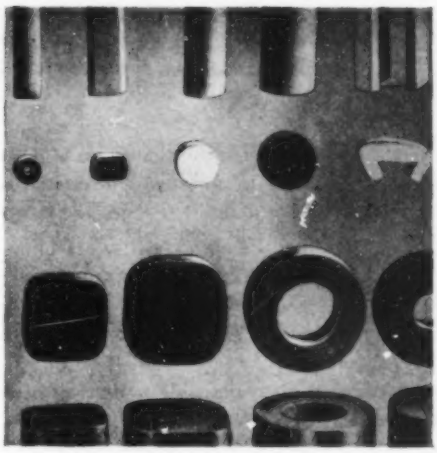
Bonding—can be bonded to almost anything with G-E silicone adhesive.

SILICONE RUBBER WASHERS ...new safety for hot-water relief valves

G-E silicone rubber washers are now widely used in relief valves for home hot-water tanks and hot-water heating systems. Unusual properties of this remarkable new material that make it ideal for valve seats are: *non-adherence to metal, low-compression set, low-water absorption and high-heat resistance.*

The many applications for G-E silicone rubber parts throughout industry include use as fire-wall seals in jet engines . . . hermetic (and chemical-resistant) seals in capacitors . . . in waterproof ignition systems for military vehicles.

Your design might suggest an unusual application for G-E silicone rubber parts, or a use already established. Investigate the many advantages of low-cost, G-E-fabricated silicone rubber parts.



TAKE ADVANTAGE OF G.E.'s LOW-COST FABRICATING SERVICE

Why not check G.E.'s low-cost service for custom-designing and mass-producing silicone rubber parts? Pioneer of silicones, General Electric offers a large staff of silicone rubber specialists to work out your parts problems. Specially developed G-E automatic equipment for making parts to precision accuracy helps General Electric keep cost to you at a minimum. INQUIRE: *SECTION F-5, PLASTICS DEPARTMENT, GENERAL ELECTRIC COMPANY, PITTSFIELD, MASSACHUSETTS.*

You can put your confidence in

GENERAL ELECTRIC

LET'S TAKE ANOTHER LOOK AT SHIMS

"laminated shims cut our assembly time 10-20%"
—pump manufacturer

"reduced our gear mesh and end play problem"
—aircraft manufacturer

"gave us .002" accuracy with .063" tolerance"
—machine tool manufacturer

"shims are cutting our machine shop expense"
—diesel manufacturer

SHIMS ARE GOOD ENGINEERING. They cut costs without sacrificing the quality of your product. Surely, this is the acid test of a machinery component. And here is how shims achieve the results:

Split bearing adjustment. Lathe head stock spindle bearing.

Bevel gear mesh adjustment for agricultural machinery.

Babbitted shim in bearing adjustment. Internal combustion engine.

REDUCED MACHINING COSTS: With the use of shims as spacers in appropriate situations, your machinery tolerances can be more flexible. Accurate shimming can achieve the final adjustment required. No standby lathe is required during assembly operations.

REDUCED ASSEMBLY TIME: Final fitting can be achieved right at the job. Parts do not need to be assembled, then disassembled and removed for further machining, grinding or filing of a few thousandths. Shims will make the adjustment immediately and easily.

REDUCED LABOR COST: Obviously, reduction of machining or assembly time reflects in lowered costs. But in addition, assembly with shims is a less skilled operation than assembly involving intermittent machining operations. No new skill is needed.

AN ADDED SERVICE FEATURE: The use of shims, particularly our own LAMINUM shims, gives you an added service feature. When parts are worn by use, the simple removal of a shim lamination can restore clearance to original requirements. Here is an exclusive feature for take-up of wear during the entire life of the machine.

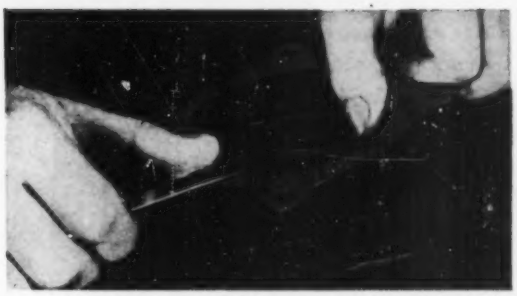
LAMINUM
THE SOLID SHIM THAT peels FOR ADJUSTMENT

SHIM ENGINEERING DATA FILE
Send for it today. Full of facts and specifications on shim materials.

4 GENERAL TYPES OF SHIMS ARE AVAILABLE

LAMINUM® SHIMS—simply peel for adjustment

Laminated shims actually peel off in .002 or .003 inch layers, providing a simple, but very accurate adjustment in spacing. The laminations peel easily with a penknife, yet the shims are in a solid unit, bonded over their entire surfaces. There's no counting, stacking or miking, as with loose leaf, separate shims. Gauge is always known. No grit can lodge between layers. The LAMINUM shim is actually less compressible than solid metal.

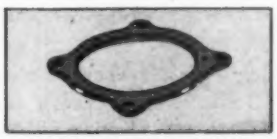


Laminated shims are stamped from brass or steel LAMINUM, the "metal that peels." They're made up of layers of .002 or .003 inch brass or steel, metallically bonded together over their entire surfaces.

Herringbone gear mesh and thrust bearing adjustments. Rotary pump.

Tapered roller bearing adjustment. Oil well drilling equipment.

Gear and magneto mounting adjustment. Aviation engine.



SPOT-SOLDERED SHIMS

Shim packs can also be provided, made up of any prescribed number of laminations with edges tack-soldered (brass only). This method of grouping laminations has some disadvantages, but meets with occasional acceptance by some designers and production men for special applications.

LOOSE LEAF SHIMS

Loose leaf shims, of course, require counting and stacking but have the occasionally important advantage of allowing a variety of shim thicknesses. No significant economy is effected because, unlike the LAMINUM shim pack each leaf is stamped as a separate unit.

SPECIAL SHIMS FOR SPECIAL PROBLEMS

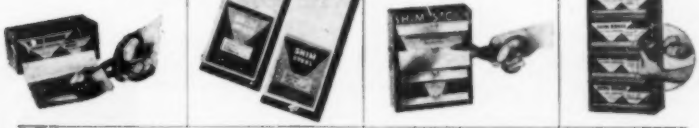
For special applications, we have devised other patented methods of joining laminations together for use in packs, particularly when the purchaser has been interested in the split second use required for high speed production.

We have made untold millions of shims in our 38 years devoted to this work. This experience might well provide an easy solution to your shim engineering problem.

The solving of your very knottiest shim problem is work that we solicit most eagerly, without obligation to you. Such assignments best further our own knowledge of shim engineering for our mutual benefit. And, inasmuch as we manufacture all types of shims, we feel well qualified to recommend impartially to you.

SHIM STOCK packaged for instant use without fumbling or waste.

Available from your Industrial Distributor, only.



RUGGED CARTON DISPENSERS | STURDY FLAT PACKETS | THE 4-GAUGE ECONOMY CARTON | THE METAL DISPENSING RACK

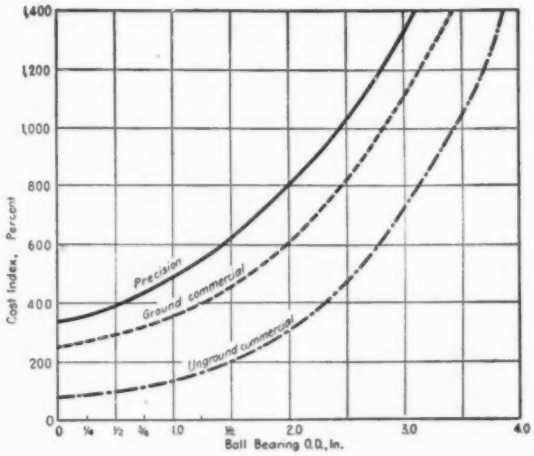
LAMINATED SHIM COMPANY, Inc.

CUSTOM SHIMS • STAMPINGS • SHIM STOCK

1410 UNION STREET • GLENBROOK, CONN.

How Much Does A Ball Bearing Cost?

Ball bearing performance in your product can be obtained at a lot less cost than you think—*if* you select the right kind of ball bearing for the right application. In many uses, "Commercial" ball bearings are often less expensive than bushings or plain sleeve bearings. In others, "Commercial" ball bearings will satisfactorily meet design specifications at a cost one-fourth to one-sixth of precision ball bearings. "Commercial" ball bearings are "naturals" for appliances, business machinery, conveyors, farm and marine equipment, mining equipment, textile machinery and a host of other engineered products.



Remember these facts when you specify ball bearings:

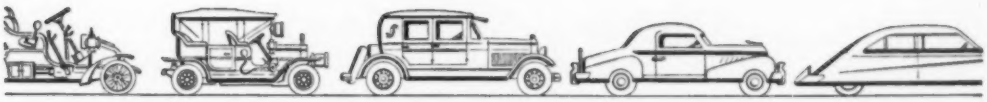
- Schatz "Commercial" bearings come in twenty-two basic types. Metric sizes are available in a number of these types.
- "Commercial" bearings come ground or unground. Grinding inner and outer races increases radial load-carrying capacity about 2.17 times, adds smoothness, allows increased shaft speeds.
- Schatz "Commercial" ball bearings are suitable for radial loads, thrust loads, or combined loadings. Thrust bearings will not carry radial load, but radial bearings will carry thrust loads up to 50% of the bearing rating.
- Schatz "Commercial" bearings have—unless otherwise specified—carburized, hardened and tempered, high-grade steel races. High-quality balls are used.
- Schatz "Commercial" bearings can be obtained with many modifications and accessories: single or double rows of balls; labyrinth or felt seals; flanged or plain outside diameters; hardened or unhardened tread; Alemite fittings; extended inner races; hexagonal bores.

IF YOU HAVE A FRICTION PROBLEM,
LET SCHATZ ENGINEERS DESIGN IT AWAY

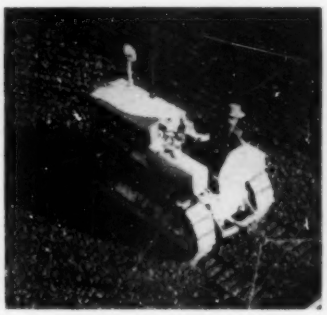
OTHER TABLES showing correct size and type "Commercial" Ball Bearings for various speed and loading conditions, and graphs for estimating bearing life, are included in "Construction and Characteristics of Low-Cost Ball Bearings." This technical booklet also discusses modifications that can be made for special design, assembly and operating conditions. Catalog No. 11 gives data on the complete Schatz "Commercial" line. Write for your copies today.

SCHATZ "Commercial" BALL BEARINGS

THE SCHATZ MANUFACTURING COMPANY • 6758 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.



The same bearing skills that help automotive progress...



also make BETTER TOOLS...BETTER TRACTORS...BETTER EQUIPMENT

The horseless carriage fostered new concepts of engineering progress, new standards of mass production. As the automotive industry has grown in abilities and accomplishment, so have its prime suppliers—like Federal Bearings.

Federal, a 43-year veteran of precision production, has always been an important supplier to the automotive field. In addition, Federal skills in research, engineering, and manufacture are being used today to check friction in tractors and farm equipment, construction machinery, machine tools and industrial machinery of all types. Here, as in the automotive field, performance is paramount, and strict engineering standards must be met.

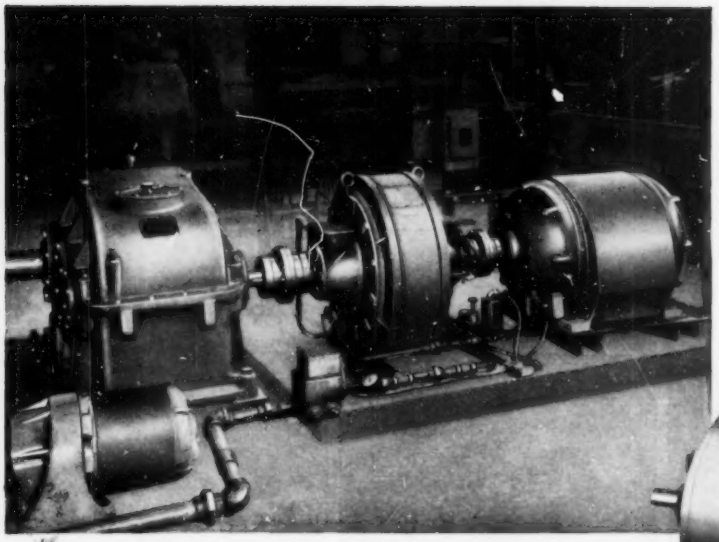
The quiet of a Federal ball bearing at work is silent testimony to Federal's skills. These skills represent the efficient combination of IMAGINATIVE RESEARCH · ADVANCED ENGINEERING · ALERT MANUFACTURING · RIGID QUALITY CONTROL · SUPER-PRECISE TESTING.

THE FEDERAL BEARINGS CO., INC.
POUGHKEEPSIE, NEW YORK
Makers of Fine Ball Bearings

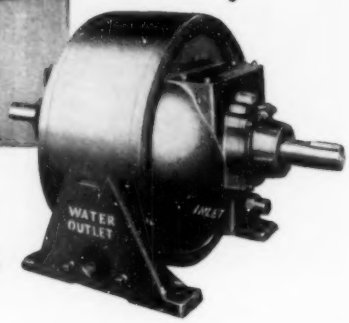
Quality since 1908

Federal
BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS



Model 6-W Dynamatic Water-Cooled Coupling driving a calender in a large rubber manufacturing plant. Power is transmitted from AC motor, 100 H.P., 1200 RPM.



ELECTRO-MAGNETIC
DYNAMATIC
EDDY-CURRENT

WATER-COOLED POWER COUPLINGS

Provide Adjustable Speed Drive Direct from AC

The Dynamatic Coupling transmits rotation from a driving to a driven member without mechanical contact—with stepless adjustable control and with almost instantaneous response. It is a simple and effective method of providing adjustable speed from a constant speed source (or vice versa) with full-torque starts. The addition of an eddy-current brake will provide smooth controlled deceleration.

Effective water-in-the-gap cooling makes possible large capacity in small space, and the construction provides complete protection of the interior of the coupling against atmospheric impurities.

A standard range of sizes of Dynamatic Water-Cooled Couplings is available for transmitting torques of 50 pounds feet up to approximately 5,000 pounds feet. Many other sizes up to and including single units for handling 200,000 pounds feet of torque are in service and units of larger capacity can be built to order.

WIDE SPEED RANGE

INSTANTANEOUS RESPONSE

ACCURATE SPEED CONTROL

STEPLESS SPEED ADJUSTMENT

SMOOTH TORQUE TRANSMISSION

TOTALLY ENCLOSED

SIMPLE • QUIET

COMPACT • EFFICIENT

Write for Illustrated Bulletin WC-1.

DYNAMATIC® CORPORATION • KENOSHA WISCONSIN

Subsidiary of **EATON MANUFACTURING COMPANY, Cleveland, Ohio**

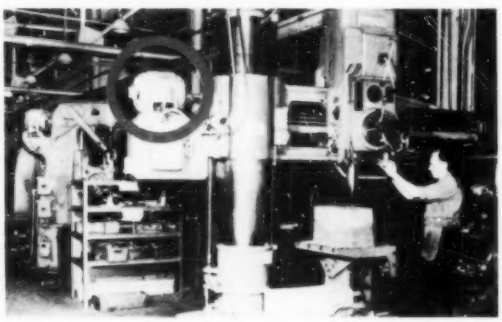
Dynamometers • Oil Well Draw-Works Brakes • Adjustable-Speed Couplings • Eddy-Current Brakes
Ajusto-Spedes • Shovel Clutches • Press Drives • Lift Truck Clutches • Electronic Controls

"We have three shifts in operation," says Julius J. Domonkos, Vice-President in Charge of Manufacturing, Bell Aircraft Corporation. "That's full production on a 24-hour day basis. For the past 10 years we've been depending on Tri-Clad motors to carry the load. We've never regretted putting our confidence in this fine motor!"

G-E Tri-Clad Motors drive the machines that are instrumental in producing helicopters, guided missiles, rocket motors, research aircraft, and jet aircraft engine nacelles for our rapidly expanding armed forces. At Bell Aircraft Corporation, G-E Tri-Clads are known as a thoroughly dependable motor —tough on the outside . . . on the inside . . . at the bearings.

BELL AIRCRAFT CORPORATION:

"We've been depending on Tri-Clad* Motors for Ten Years . . ."



This Tri-Clad driven radial drill takes care of most of the large dies for the entire Bell plant. Big dies and bolster plates are drilled and tapped on this machine, a critical part of the Bell operation. Despite continuous u.e. plant personnel can't remember a single interruption due to Tri-Clad failure!

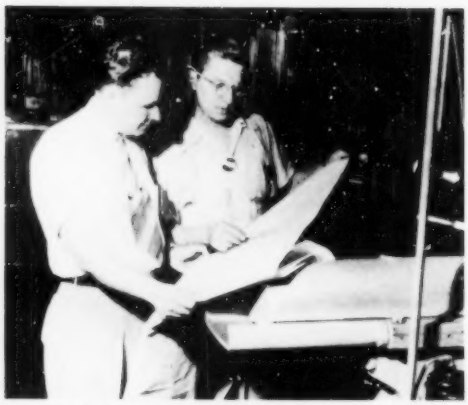
FASTEST BOMBER IN THE WORLD! Jet engine nacelles for the 600-plus miles-per-hour B-47 are being produced at a record-breaking clip in the Bell plant at Buffalo, N. Y. The "Stratojets" represent a major advance in bombardment aircraft.

*Reg. trademark of General Electric Co.

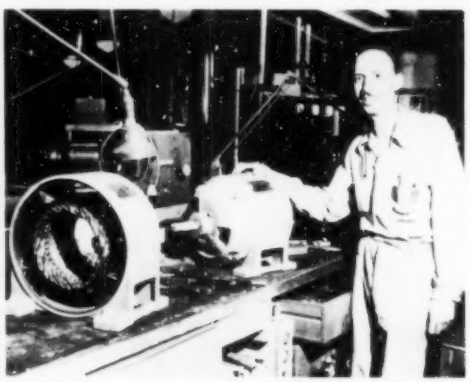
GENERAL ELECTRIC

TRI CLAD MOTORS

Help keep Bell Aircraft production up!

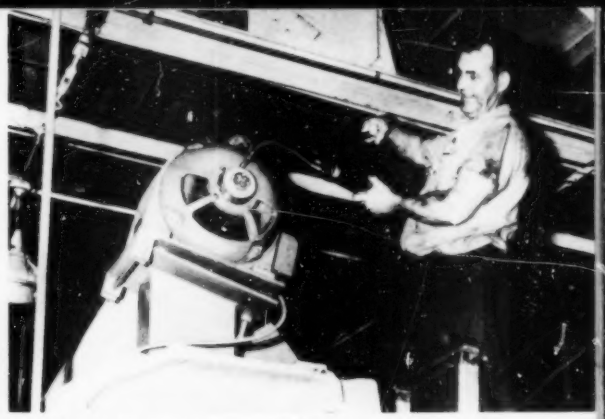


Marvin Limburg (left), Foreman of Bell's Tool and Die Shop, comments, "I don't believe we've ever lost machine time due to breakdown of Tri-Clad motors. And our jig-borers, for example *have been operating around the clock for the last 8 to 10 years!*"

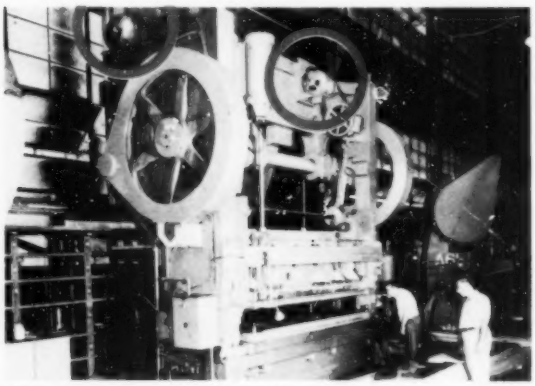


"It's the easiest motor we have to maintain" according to Maxwell Anderson, Crew Chief of Bell's motor repairmen. "There's more working room inside and more room in the slots. It's become a byword with us that if you give a Tri-Clad motor ordinary care you'll never have to worry about maintenance."

TIMELY READING—With every electric motor needed on the line, you'll want a copy of the G-E manual on "How to Maintain Motors and Generators." It's free, just ask for bulletin GET-1202. *Sect. 752-10, General Electric Company, Schenectady 5, N. Y.*



Greasing isn't necessary on a Tri-Clad motor in normal service, but it's always reassuring to know that you *can* lubricate if you so desire, without time-consuming disassembly. The photo shows how easy it is: remove relief plug, attach the grease gun nozzle, squirt—the job is finished.



This huge punch press is an important tool maker. Anton Geiser (right), assistant punch press foreman, says: "I can't recall a single shutdown of this section due to motor failure." Almost all motors in this department are Tri-Clad. This is another Bell Department which has been operating around the clock; cannot afford to lose time because of motor breakdown.

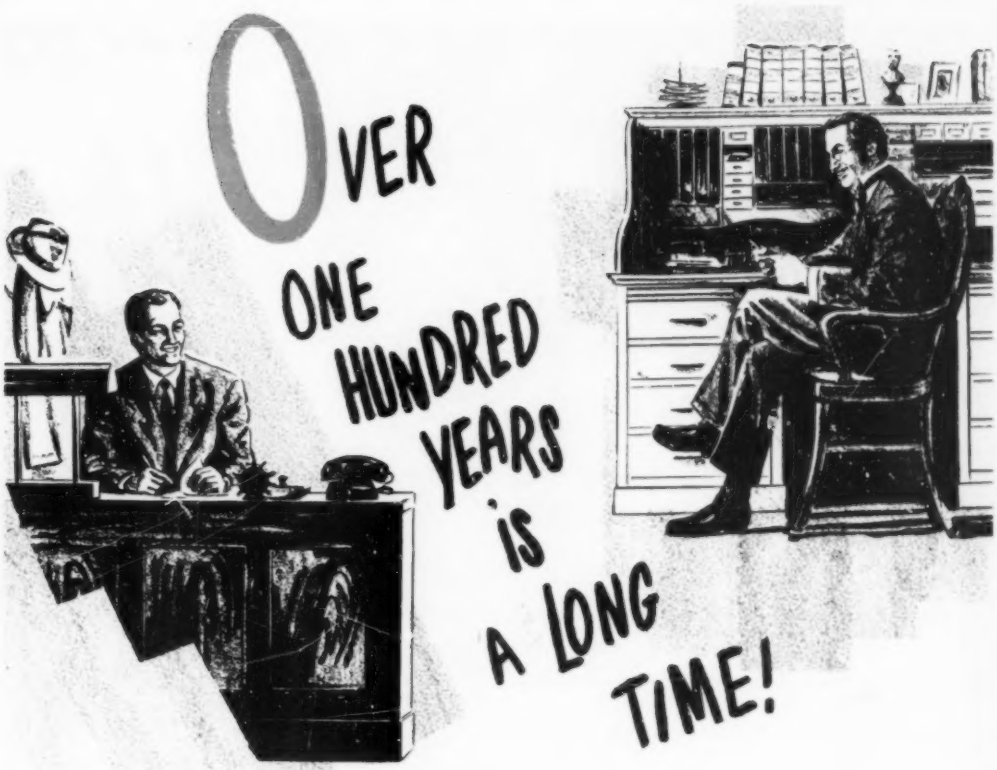
NEW! A Helpful Training Course on Motors!

Everyone concerned with technical training problems will want this new G-E Motor Selection and Application Course. Consists of 9 short, easily understood lessons. Complete kit —slide films, review booklets and instructor's manual— $100.00. Call or write your nearest G-E sales office.

Look at the Scope of this Course

1. Fundamentals of Motors
2. Types of Motors
3. Fundamentals of Selection
4. A-C Induction Motors
5. Single-phase Motors
6. D-C Motors
7. Synchronous Motors
8. Adjustable-speed Drives
9. Gear Motors

GENERAL ELECTRIC



Yes—100 years is a long time to be in business—particularly in the past century when America has seen so many changes . . . boom periods and depressions, the development of push button production, jet planes and skyscrapers. It's no accident that STANDARD VARNISH WORKS and TOCH BROTHERS, Inc. survived and expanded during this trying but glorious century. They relied on the consistently high performance of their products to keep their names in the front ranks. Through research and exhaustive laboratory and field testing they developed new product finishes for industry, new techniques and chemicals for the protection of masonry structures, and pioneered in the home decorating field. They are justly proud of their hundred year record, and today, with this long successful history behind them, and products that have gained nation-wide recognition, they are uniting under the banner of STANDARD-TOCH CHEMICALS, Inc., beginning a new period of expansion and inventiveness that promises to be even more illustrious than the past.

STANDARD VARNISH WORKS, (N. Y.)
STANDARD VARNISH WORKS, (ILLINOIS)
STANDARD VARNISH WORKS OF CALIFORNIA
STANDARD VARNISH WORKS OF MICHIGAN
TOCH BROTHERS, INC.
R.I.W. WATERPROOFING CORPORATION
TOCH MARINE CORPORATION
NATIONAL VARNISH COMPANY INC.

STANDARD-TOCH CHEMICALS, *Inc.*
NEW YORK LINDEN, N. J. CHICAGO

ONLY A

Flexible, Leakproof Bellows COULD SOLVE

the case of the vacuum variable capacitor

When Jennings Radio Manufacturing Company first considered making vacuum variable capacitors, one of the big difficulties was finding a suitable seal. Ordinary sealing methods would not permit moving the adjustable plate while maintaining the vacuum.

What Jennings needed was a seal that would be both LEAKPROOF and FLEXIBLE.

The solution was Clifford Hydron Bellows. Their leakproof quality forms a perfect seal for the vacuum yet their flexibility permits full movement of the variable plate! What's more, they remain vacuum tight after going through silver solder brazing in two areas . . . and they easily withstand the 480°C bake-out after brazing.

The use of these bellows has helped make possible the first practical vacuum variable capacitor. Jennings now offers capacitors for high power, high voltage work that permit quick, precise frequency shifting of even the largest transmitters.

Clifford Bellows have many applications in any of these categories. (1) actuating switches or valves for accurate control of temperatures or pressures; (2) sealing rotary shafts or packless valves against liquid or gas leakage; (3) providing a flexible joint for instruments combining rotary motion and hermetic seal; (4) transmitting motion hydraulically to remote points.

See how you can put LEAKPROOF, FLEXIBLE, metallic bellows to work for you . . . send coupon below today.

P.S. Clifford engineers will gladly make a confidential analysis of your sketches and specifications without cost or obligation.

CLIFFORD

HYDRAULICALLY-FORMED BELLOWS AND BELLOWS ASSEMBLIES

ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES

CLIFFORD MANUFACTURING COMPANY, 122 Grove Street, Waltham 54, Massachusetts
Division of Standard-Thomson Corporation
Sales offices in New York 17, Detroit, Chicago 1, Los Angeles

FREE! **Please send me my copy of the bulletin "What to Consider When Selecting a Metallic Bellows". I am interested in the applications checked.**

- ☐ Air conditioning systems
- ☐ Aircraft
- ☐ Carburetor altimeter controls
- ☐ Engine thermostats
- ☐ Gasoline valves
- ☐ High pressure steam devices
- ☐ Heating equipment
- ☐ Instruments
- ☐ Remote or direct control of temperature and pressure
- ☐ Compensating regulators
- ☐ Electric or gas ranges
- ☐ Kilns & ovens — industrial
- ☐ Air compressors
- ☐ Oxygen flow indicators
- ☐ Oxygen regulators
- ☐ Process controls
- ☐ Refrigerating systems — commercial
- ☐ Shaft seal assemblies
- ☐ Fuel pumps
- ☐ Fluid couplings
- ☐ Supercharger controls
- ☐ Refrigerator controls — domestic
- ☐ Torque converters

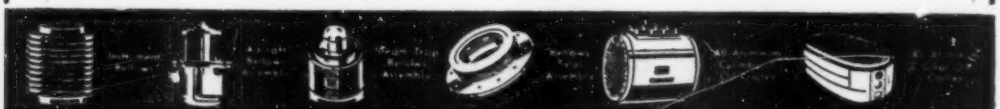
Other applications .....

Name ..... Title .....

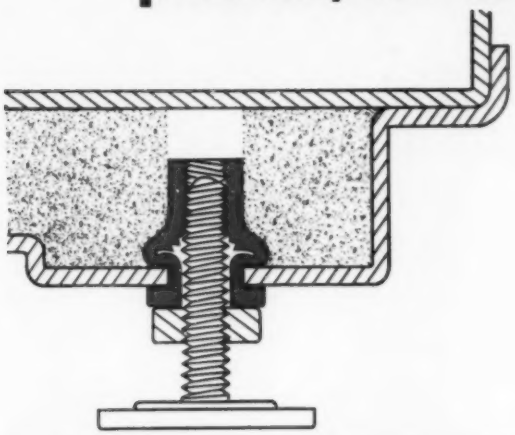
Firm .....

Street .....

City ..... Zone .... State .....



RIVNUTS solve refrigerator fastening problem, cut assembly costs



REFRIGERATOR designers had a puzzler on their hands in finding a way to fasten leveling feet to the cabinet. The metal was too thin to tap, and welding would warp it. Besides, the threads would be ruined in the enameling process.

A'. these problems were solved by a B. F. Goodrich Rivnut—the *only* one-piece blind rivet with threads! Working from one side of the cabinet, one man installs the Rivnut in a few seconds. The easy-to-use power heading tool forms a bulge in the Rivnut shank—a "second head" that tightly grips the material. At least six threads remain clean to take the leveling-foot screw. Installation is made *after* enameling without marring the finish.

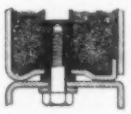
Besides these advantages, the quick, simple installation of Rivnuts saves time, cuts assembly costs. For help on your fastening problem, write The B. F. Goodrich Company, Dept. PE-101, Akron, Ohio.

What's your toughest fastening problem?

TORQUE?

Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?

Even in thin materials, Rivnuts provide at least 6 threads for attachment.

ATTACHMENT?

Fasten *with* Rivnuts—fasten *to* Rivnuts. Makes possible multiple fastening.

FINISH?

Rivnuts can be installed after paint or porcelain finish is applied.

LOAD?

Typical Rivnut thread strength: 6-32—964 lbs.; 8-32—1096 lbs.; 10-32—1326 lbs.*

RIVNUTS *lick them all!*

*Figures given for aluminum. Loads for brass and steel Rivnuts about double.

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Company, Department PE-101, Akron, Ohio.

We may KNOCK YOUR HAT OFF

with our Quote on SAVINGS AND DELIVERY

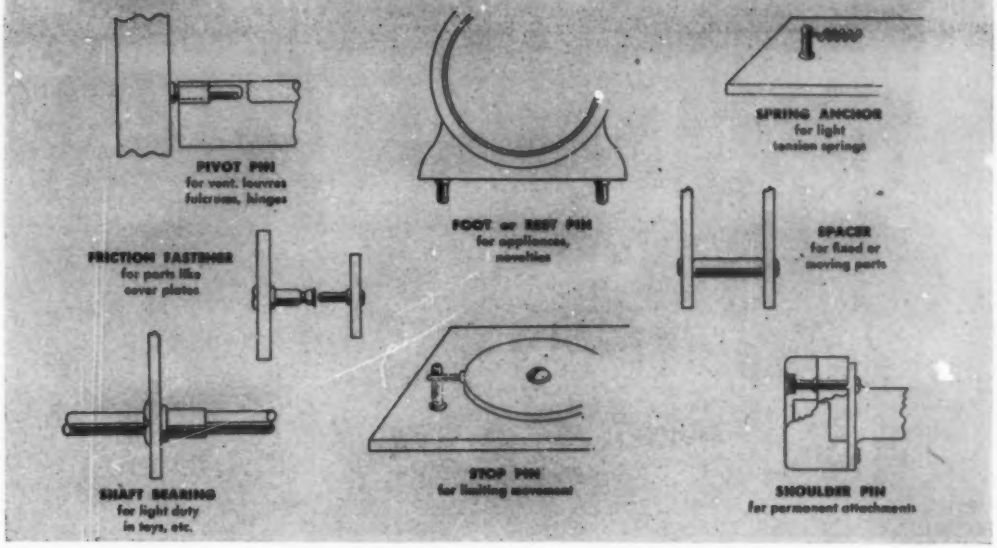
If you're a Big User of Tiny Parts Such as These!

Sound like exaggeration? Not when you know that the electronic tube industry looks to The Bead Chain Mfg. Co. for its millions of radio tube pins. Or, that the economy-minded builders of electrical apparatus turn to us for the contact pins, terminals, jacks and sleeves required in tremendous quantities.

For pin-like parts, and variations of bushings needed for *mechanical* purposes, as well, we are the money-saving supplier to scores of famous makers of products like toys, business machines, appliances, ventilators.

You save . . . if we can make it! We can almost say with certainty that if we can make that part *(up to ¼" dia. and to 1½" length)* you use in large quantities, we can show you a big saving. And, assure on-time deliveries to meet your defense work schedules! We have something unique back of that claim . . .

Low Cost Way to Get Parts for Many Mechanical Uses



Nobody has What We Have! To be able to produce our famous Bead Chain to sell for pennies per yard, we had to develop *our own* equipment and method . . . our *Multi-Swage Method.*

Instead of turning and drilling parts from solid rod, or stamping and forming them, our Multi-Swage Method automatically swages them from flat stock into precision tubular forms, with tight seams. By increasing the production rate many times and eliminating scrap, this saves a large part of the cost by other methods.

What We Can Make. Parts may be beaded, grooved, shouldered, and of most any metal. Generally, should not exceed ¼" dia. or 1½" length. Catalog shows many *Standard Items* available in small quantity. *Special Designs* must usually be ordered in lots of a half-million or more, unless they are frequently reordered.

Get Cost Comparison. Send blueprint or sample and quantity requirements. Our engineers will return an eye-opener on economy.

Let **BEAD CHAIN** *make it by the*

MULTI-SWAGE METHOD

BEAD CHAIN®—Kinkless Chain of a Thousand Uses

Used in countless ways to add convenience, and sales features to products . . . at negligible cost. Always the finest pull chain and parts retainer. Bead Chain offers widest choice of bead sizes and shapes, metals, colors, attachments and fittings, and experienced application aid.

I want this Catalog — Data Folder

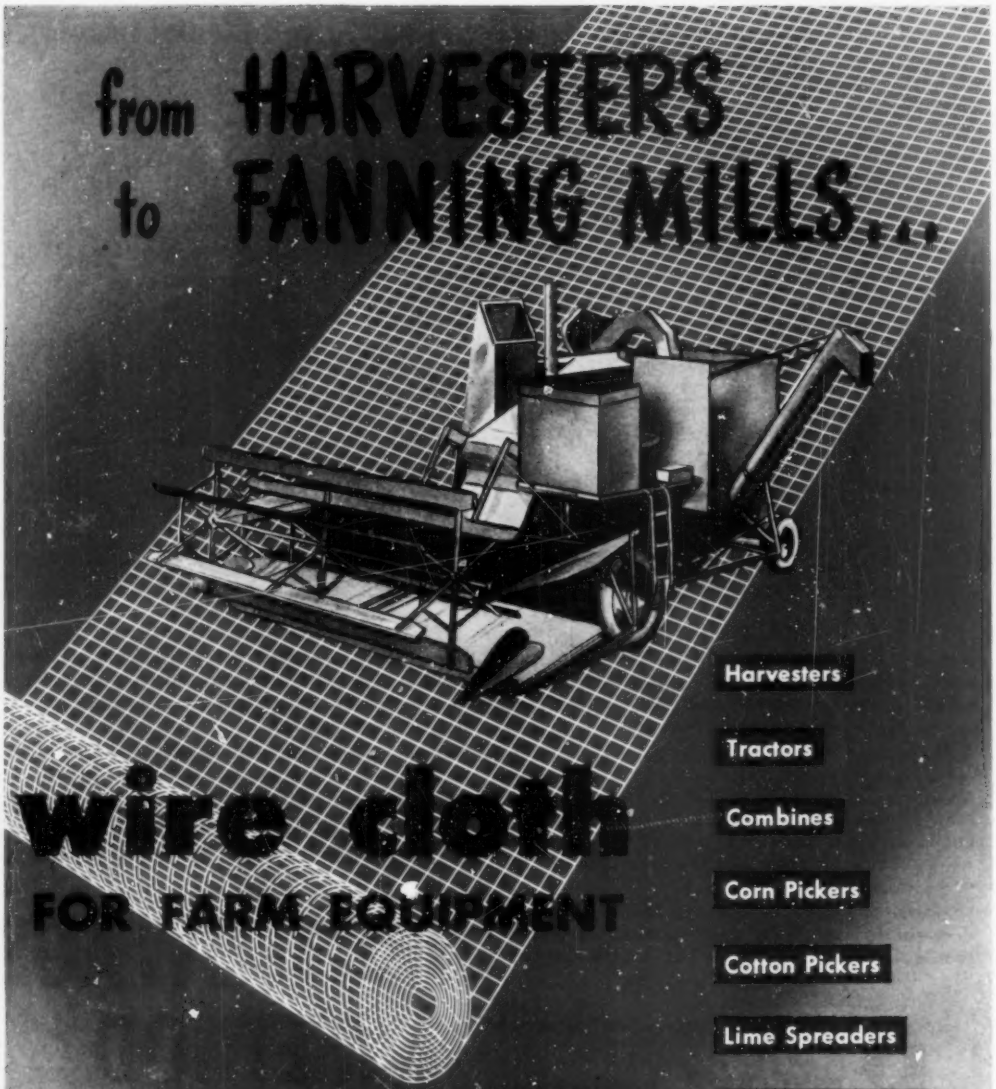
The Bead Chain Manufacturing Co.
92 Mountain Grove St.,
Bridgeport, Conn.

Name, title _____

Company _____

Address _____

from HARVESTERS to FANNING MILLS...



wire cloth FOR FARM EQUIPMENT

- Harvesters
- Tractors
- Combines
- Corn Pickers
- Cotton Pickers
- Lime Spreaders
- Orchard Sprayers
- Fanning Mills

Even though the types of farm equipment are as different from each other . . . even though the uses of industrial wire cloth in that farm equipment are so many, and so wide, and so varied . . . Reynolds wire cloth has proven its dependability over and over again. And yet farm equipment is only one of several industries that Reynolds wire cloth is serving so satisfactorily. Reynolds has more than fifty years' experience. A consultation on your wire problems costs you nothing.

REYNOLDS WIRE DIVISION
NATIONAL-STANDARD COMPANY

DIXON, ILLINOIS

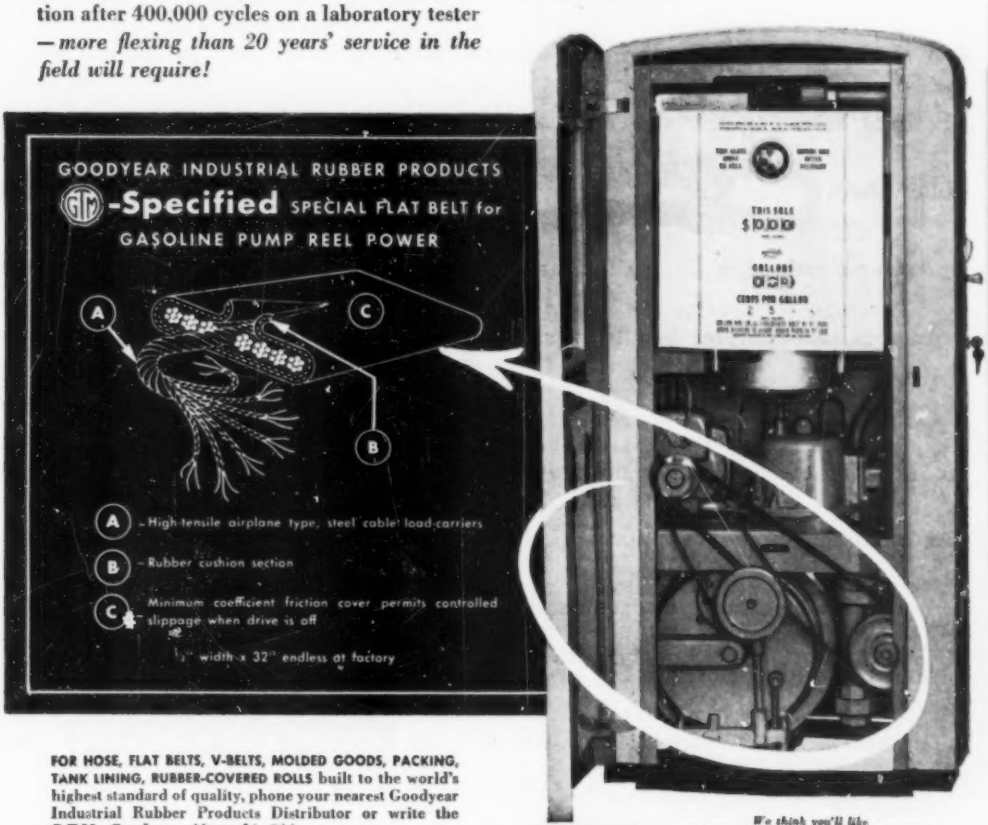
NS NATIONAL-STANDARD Company NILES, MICHIGAN

Laboratory tests show

20 YEARS' SERVICE-PLUS

A LEADING gasoline-pump maker wanted a special flat belt to withstand severe service on his new reel-type pump — turned to the G.T.M.—Goodyear Technical Man—for recommendations. The Goodyear Steel Cable Flat Belt he recommended is still in excellent condition after 400,000 cycles on a laboratory tester *— more flexing than 20 years' service in the field will require!*

Wherever you use rubber in the products you design and manufacture—hose, belting, molded items or any other form—it will pay you to turn to the G.T.M. for help to be sure of the longest, lower-cost service. Write him c/o Goodyear, Akron 16, Ohio.


GOODYEAR INDUSTRIAL RUBBER PRODUCTS
GTM-Specified SPECIAL FLAT BELT for
GASOLINE PUMP REEL POWER
A
B
C
A - High-tensile airplane type, steel cable load-carriers
B - Rubber cushion section
C - Minimum coefficient friction cover permits controlled slippage when drive is off
½" width x 32" endless at factory

FOR HOSE, FLAT BELTS, V-BELTS, MOLDED GOODS, PACKING, TANK LINING, RUBBER-COVERED ROLLS built to the world's highest standard of quality, phone your nearest Goodyear Industrial Rubber Products Distributor or write the G.T.M., Goodyear, Akron 16, Ohio.

We think you'll like
"THE GREATEST STORY EVER TOLD"
Every Sunday – ABC Network

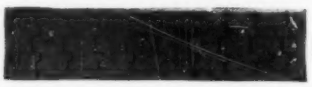
GOODYEAR

THE GREATEST NAME IN RUBBER

Why take it for

We don't know the reason, but somehow chains seem to be taken for granted. If a chain for driving, timing or conveying has operated reasonably efficiently, that same chain is specified year after year. Yet, case after case shows that important savings can be made if these important functions are viewed with an eye for cost reduction and improved performance. For example:

● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop®  he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain—¼-inch pitch Baldwin-Rex No. 25 —and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain, he not only cut his costs but the chain lasted far longer.

granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain. The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

● To a manufacturer of construction machinery, who had been using cast manganese steel chains, a Rex Field Sales Engineer recommended the use of Rex Steel Chabelco Chains. Since these chains are designed for efficient operation under dusty, dirty conditions, longer service life for both chains and sprockets at lower overall costs resulted.

Chain Belt COMPANY OF MILWAUKEE

Because Rex Field Sales Engineers have all the resources of a complete chain line at their command, they can recommend without prejudice the exact type or size of chain that will deliver the most efficient performance at the lowest cost to you and your customers. You'll find it will pay you to consult with him regarding your chain application problems. Call or write your Field Sales Office, or mail the coupon.

REX
® BALDWIN-REX

REX CHAIN & TRANSMISSION DIVISION
Milwaukee 4, Wisconsin

BALDWIN-DUCKWORTH DIVISION
Springfield 2, Massachusetts

CHAIN BELT DISTRICT SALES OFFICES

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Birmingham	Denver	Louisville	Portland
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Chicago	Indianapolis	Minneapolis	Seattle
Cincinnati	Jacksonville	New York	Springfield
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***REX* STOCK-CARRYING WAREHOUSES**

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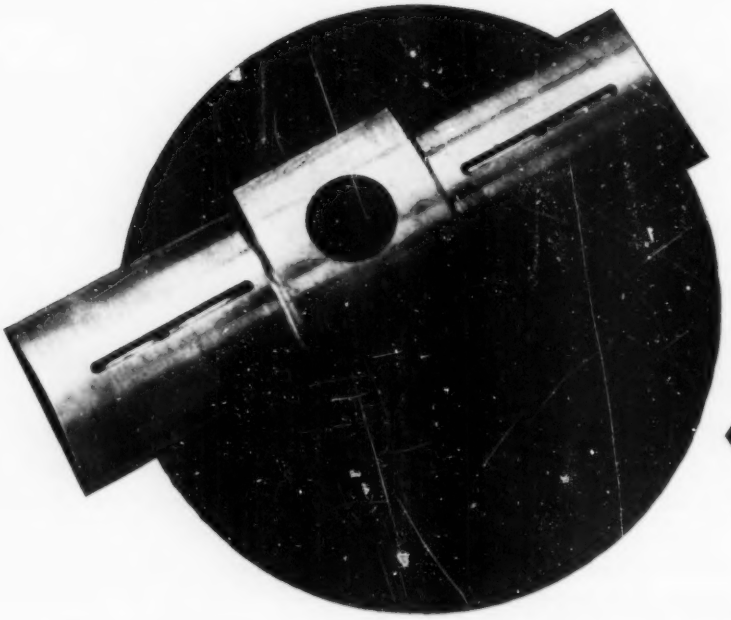
Chain Belt Company 51-106
1719 W. Bruce St., Milwaukee 4, Wis.
Gentlemen:
I am particularly interested in.....
Please send descriptive literature.
Name.....
Company.....*Dept.*.....
Address.....
City.....*State*.....



N-B-M Meadville . . . a plant that's worth seeing! Visits from Blast Furnace Superintendents and other Steel Mill Officials are welcome. When can you make an inspection trip?

why did this slipper ELIMINATE 2 OUT OF 3 REPLACEMENTS?

How an alloy developed by N-B-M Research resulted in 1 slipper with the service life of 3

One of the toughest applications you'll find for testing the mettle of a bronze alloy is Blooming Mill Slippers . . . they take the shock, stresses and frictional wear of the mill driving universals. As an example of the tough service involved, aluminum bronze slippers formerly used in a large Eastern steel company's blooming mill averaged just 3 months' service life before wearing out.

Our engineers suggested a change to N-B-M Alloy 10-B—a Bronze specially developed by National Bearing Research, for this purpose.

Result? Slippers cast from this N-B-M Alloy averaged 9 months of service instead of 3 . . . eliminated 2 out of 3 replacements! Performance was so far superior that this steel company now standardizes on N-B-M Slippers throughout the mill.

We're proud of examples like this . . . because they show how effectively our facilities for Research and Engineering—combined with 78 years of practical experience—make money-savings solutions to problems on . . .

- Slippers
- Roll Neck Bearings
- Housing Nuts
- Bronze Bars
- Babbitt Metals
- Tuyeres
- Tuyere Coolers
- Valves
- Valve Seats and Plugs
- Monkeys

AMERICAN Brake Shoe COMPANY

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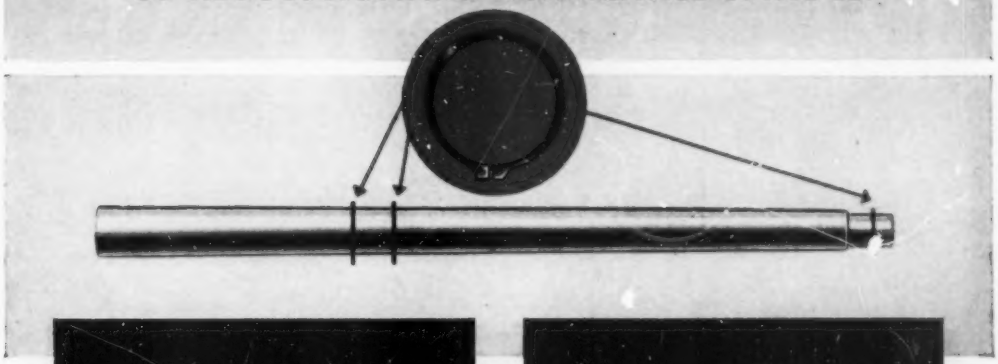
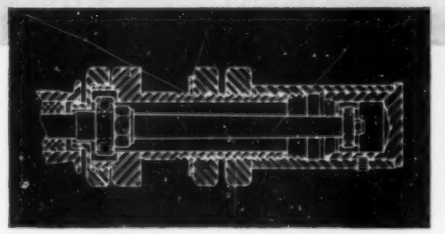
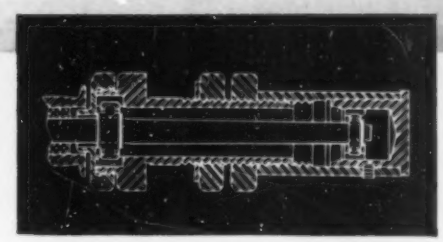
PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

3 TRUARC RETAINING RINGS LOWER COST... IMPROVE PERFORMANCE OF REVOLUTIONARY NEW TEXTILE SPINDLE!





OLD CONSTRUCTION. To position 2 ball bearings, an oversize diameter rod had to be turned on a lathe to provide 3 shoulders. In addition, blade required 2 threading operations . . . 2 lock nuts . . . separate tapering operation. Proper pressure of nuts against ball bearings required skilled labor adjustment.



NEW CONSTRUCTION. Standard rod, equal in diameter to finished blade is used. Three grooves for Truarc Rings and shoulder are made quickly and easily on screw machine. Blade is economically tapered by centerless grinding. Truarc Rings maintain correct pressure on ball bearings for life of unit!

The H & B American Machine Company's new anti-friction CENTURY spindle is probably the most mechanically advanced spindle on the market today. Waldes Truarc Retaining Rings have eliminated many of the material, tooling and assembly costs...have kept its price competitive. Truarc Rings not only simplify spindle assembly, they position ball bearings accurately...simplify maintenance...eliminate skilled labor...improve performance! And there are Truarc Rings to solve any design or re-design problem!

Redesign with Truarc Rings and you too will cut costs.

Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

SEND FOR NEW BULLETINS

WALDES

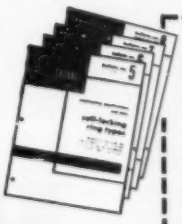
TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,362,947; 2,362,948; 2,416,052; 2,420,921; 2,428,341; 2,430,788; 2,441,648; 2,459,165; 2,461,350; 2,463,303; 2,467,803; 2,467,803; 2,481,304; 2,500,081 AND OTHER PATENTS PENDING.



Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below.

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings

PN 103

Name _____

Title _____

Company _____

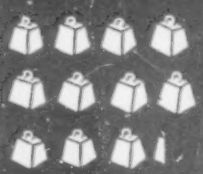
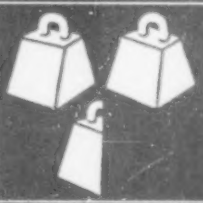
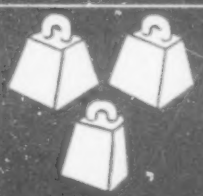
Business Address _____

City _____ Zone _____ State _____

5678

Examples of Savings of Metals.

DIE CASTINGS

PART	WEIGHT AND METAL IN DIE CASTING	SAVING OF METAL OVER OTHER METHODS
ALUMINUM BOOSTER CUP		
ALUMINUM FUZE HEAD		
ALUMINUM FUZE BODY		
BRASS BOOSTER CASING		

In the present emergency, Doehler-Jarvis is ready with 100 per cent increase in capacity since World War II, with seven plants located strategically in the following cities:

TOLEDO, O.

POTTSTOWN, PA.

GRAND RAPIDS, MICH.

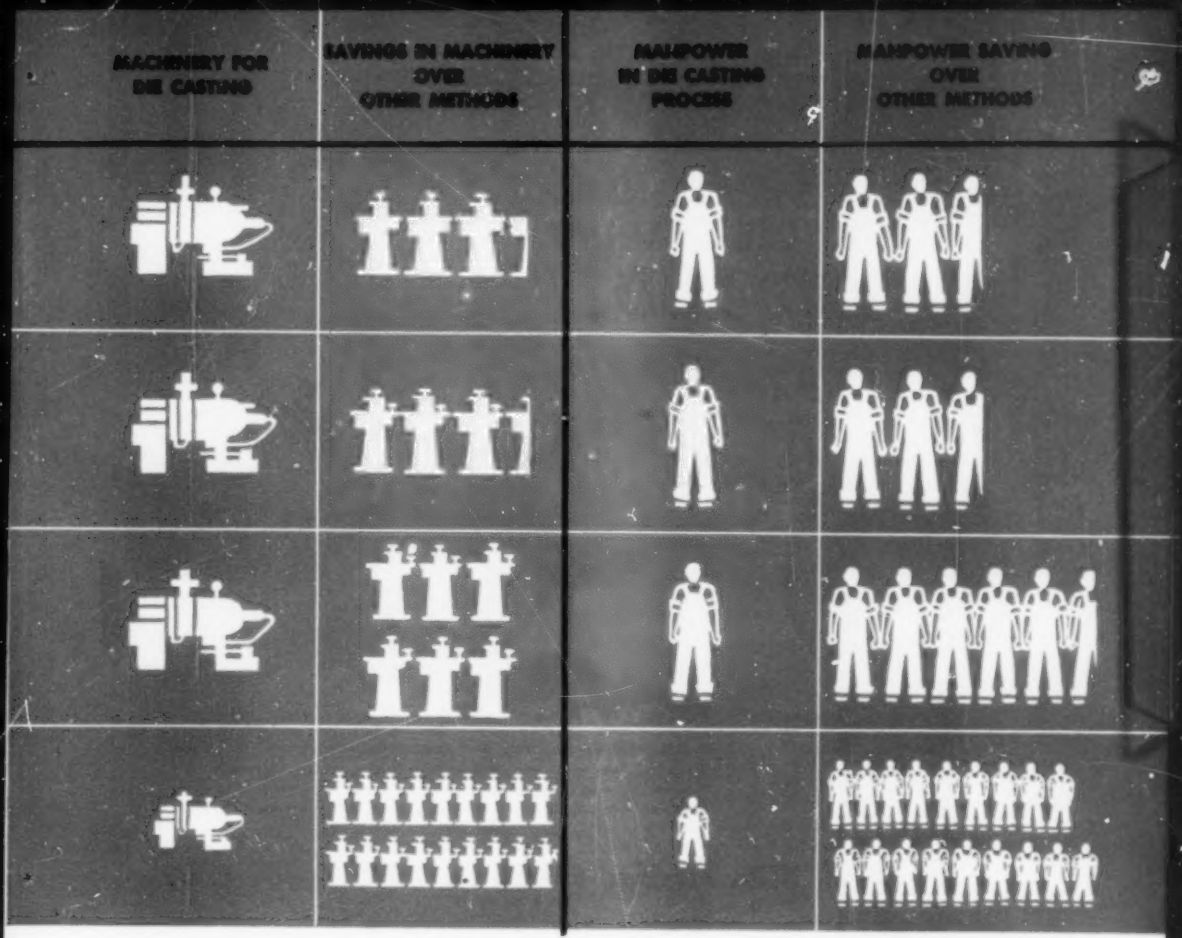
BATAVIA, N. Y.

CHICAGO, ILL.

Doehler-

Machines and Manpower by Using

in Armament Production


MACHINERY FOR DIE CASTING
SAVINGS IN MACHINERY OVER OTHER METHODS
MANPOWER IN DIE CASTING PROCESS
MANPOWER SAVING OVER OTHER METHODS

The World's Largest Producer and Finisher of Die Castings

Jarvis **CORPORATION**

Executive Offices, New York

DOEHLER-JARVIS

ROTARY AIR-BLAST DRILLING

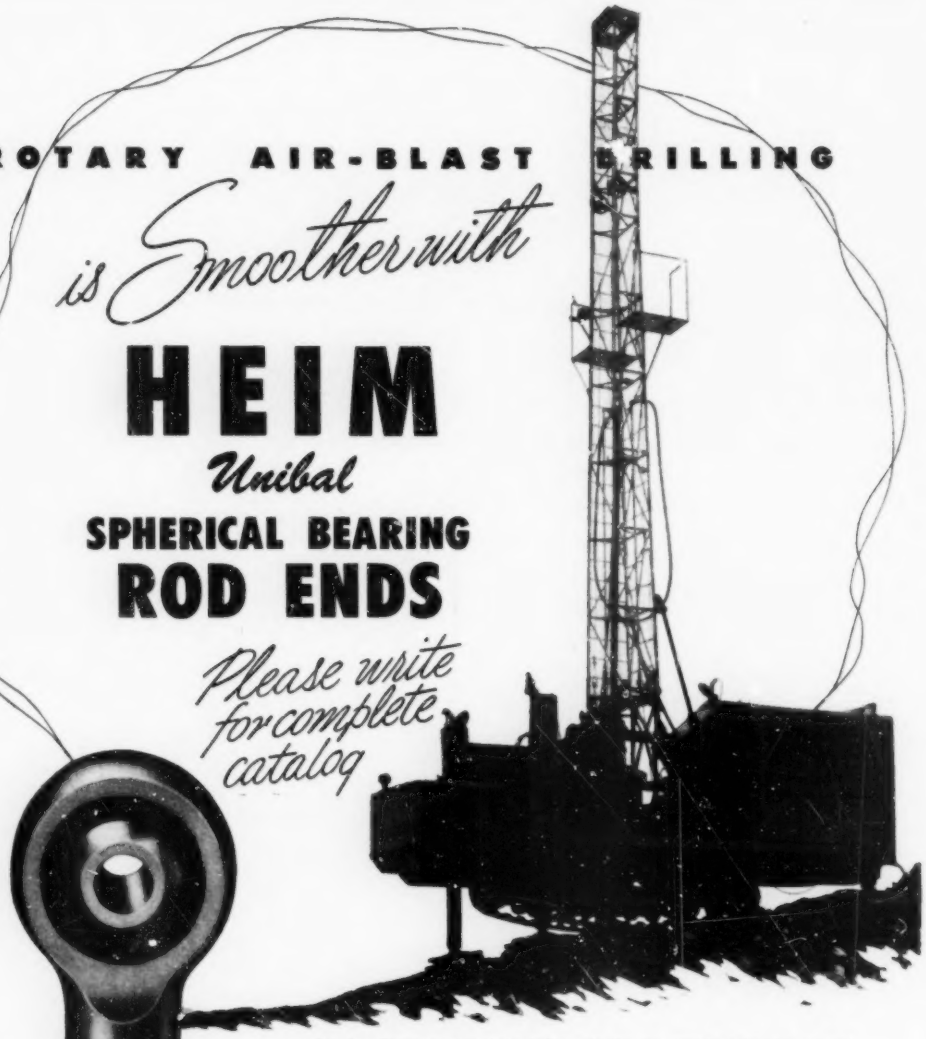
is Smoother with

HEIM

Unibal

SPHERICAL BEARING ROD ENDS

Please write for complete catalog



The Joy Champion Blast Hole Drill, made by Joy Manufacturing Co., is used for drilling holes for blasting in quarries, open-cut metal and non-metallic mines, and other excavation. It is a continuous-type rotary drill, which drills dry, uses a tri-cone, roller-type bit and a blast of compressed air for removal of cuttings.

HEIM *Unibal* SPHERICAL BEARING ROD ENDS

deserve *your* consideration for use in any linkage mechanism, whether on giant equipment like this Champion Drill, or on smaller machines or products.

THE HEIM COMPANY

FAIRFIELD, CONNECTICUT

Filament nylon cloth is now "set" to prevent shrinkage in the finished garment by using Calrod heaters mounted several inches above . . .

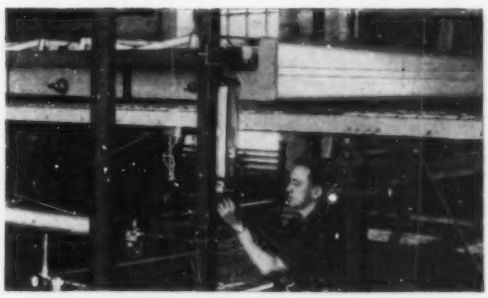
NEW TEXTILE MACHINE DEVELOPED

Built-in Calrod* heaters enable continuous radiant-heat equipment to replace batch-type process

Radiant-heat setting of nylon on the production line now eliminates four very costly steps from the eight handling operations . . . and now uses semi-skilled labor. "The new Nylon Electrosetter gives our customers faster production at much lower cost per yard *solely* because of built-in electric heat," says John McCreary of McCreary Machine Works, Inc., Cohoes, N. Y. "And we chose Calrod heaters because they are easy to install, require almost no maintenance and are extremely reliable at temperatures even above 1300 F. When nylon valued at $3000 per hour runs on the tenter frame . . . the heat *must* be reliable."

If you build equipment for a process which requires heat, why don't *you* make it a production line operation? Calrod heaters are easy to install and require little maintenance. Whether your application is radiant heating, heating liquids, surfaces, air, pipelines, or melting soft metals, there is a G-E Calrod heater for the job. And recommendations of a G-E Heating Specialist may help you as they helped McCreary. WHY DON'T YOU present your requirements to the nearby G-E Sales Office, or write to ***Sect. 720-51, General Electric Co., Schenectady 5, N. Y.***

*Registered Trademark



. . . the tenter frame. G-E Reactrol* Control keeps the speeding nylon web at the exact setting temperature . . . only 25 F below the fusion point.

NEW SELLING AID

Gummed labels are now available to help tell your customers that your machinery is equipped with the best in "built-in heat" . . . G-E Calrod Heaters.

GENERAL ELECTRIC

720-51

IMMEDIATE DELIVERY

from NEW YORK, CHICAGO, KANSAS CITY, NEW ORLEANS, DALLAS AND LOS ANGELES WAREHOUSES

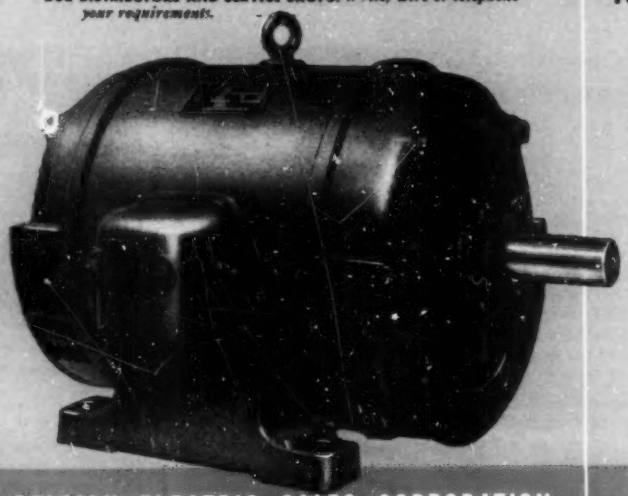
ACEC

Integral Horsepower Electric Motors— ¾ to 200 hp.

Motors made by one of the largest manufacturers of electrical equipment on the continent . . . the 70-year old firm, Ateliers de Constructions Electriques de Charleroi of Belgium . . . are now stocked—¾ to 200 horsepower—in six U. S. cities, making it possible for American customers to receive immediate deliveries out of warehouse inventories.

Manufactured strictly to **NEMA FRAMES AND SPECIFICATIONS,** *ACEC motors for 3 phase current incorporate the electrical and mechanical excellence that only long experience and scientific research can produce. The ACEC of Belgium has long specialized in the complete equipment of power stations throughout the world. Quite natural, therefore, that ACEC motors enjoy world-wide recognition.*

Branches and representatives of ACEC blanket 50 countries of the globe. Service in the United States alone is available from **232 DISTRIBUTORS AND SERVICE SHOPS.** *Write, wire or telephone your requirements.*



All ACEC Motors are FULLY GUARANTEED

Available in the following types:

- Open Drip Proof Motors
- Totally Enclosed Fan Cooled Motors
- Pump Motors:
  - Style "C" Face Mounted
  - Style "P" Vertical Solid Shaft Submersibles
  - Vertical Hollow Shaft
- Adjustable Speed Schrage Motors.

Motors exceeding 200 hp. are built to order.

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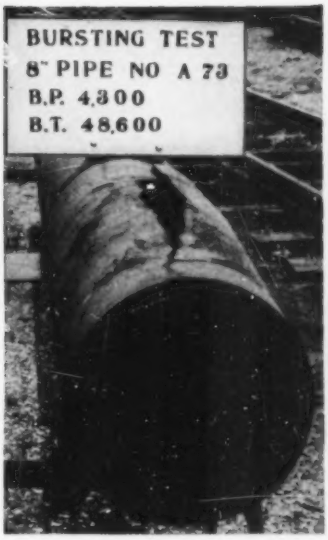
Sole representatives of ATELIERS DE CONSTRUCTIONS ELECTRIQUES de CHARLEROI

Electrical Engineers and Manufacturers

CRUSHING TEST: Ductile iron pipe sections, tested to fracture in compression, reveal the superior ductility of this new engineering material. Its strength and toughness make ductile iron an excellent material for tubular products. The average ring modulus of rupture on 8" diameter rings so tested by Underwriters Laboratories was 127,650 p.s.i. Photographs shown here were furnished by Lynchburg Foundry Company, Lynchburg, Va.



BURSTING TEST: This 8" diameter pipe was cast in ductile iron, welded with Ni-Rod 55® (nickel welding rod developed for cast iron) and then subjected to bursting tests. Average internal bursting pressure: 4,300 lbs. Average bursting tensile strength: 48,600 p.s.i. All cracks occurred outside of the weld, with no shattering.

DUCTILE IRON'S SUPERIOR PROPERTIES

revealed by crushing and bursting tests

DUCTILE IRON is a cast ferrous product that combines the *process advantages* of cast iron with many of the *product advantages* of cast steel.

In less than two years, ductile iron has attained wide acceptance because it offers excellent castability, high mechanical properties, and good machinability. Parts cast in ductile iron show superior pressure tightness, high modulus and resistance to shock.

Typical current applications include ball joints, brake drums, cover hangers for soaking pits, gears on agricultural machinery, large valves, pressure heads for pumps, snow guards and plow points.

AVAILABILITY: Send us details of your prospective uses, so that we may suggest a source of supply from some 100 authorized foundries now producing ductile iron under patent licenses.

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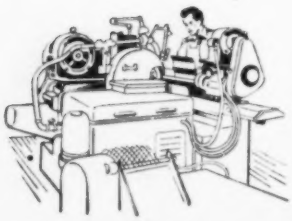
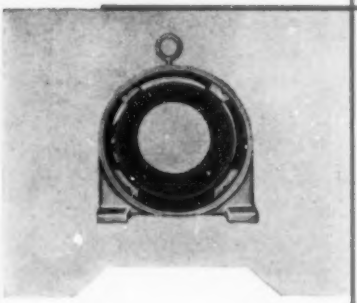
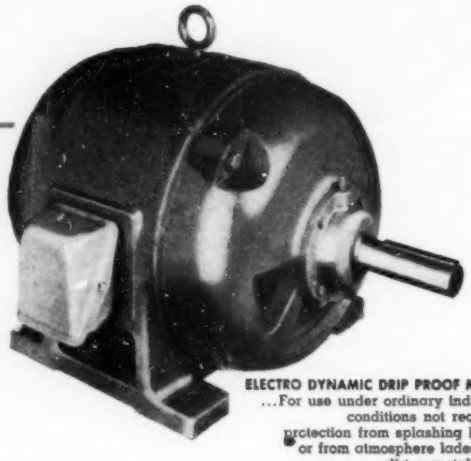
ELECTRO DYNAMIC MOTORS
laugh at down-time!







ELECTRO DYNAMIC DRIP PROOF MOTOR
...For use under ordinary industrial conditions not requiring protection from splashing liquids or from atmosphere laden with dirt or metal chips.

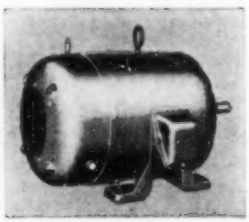
Extra Care and Superior Materials At the Windings Reduce Motor Failure To the Vanishing Point

Thanks to long experience in the exacting marine field, Electro Dynamic knows how to build industrial motors that stand up under the most gruelling kind of use. And that's mighty important today.

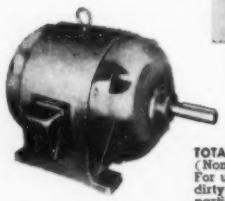
E. D. motors are tough where motors should be tough —at the *windings*, "the heart of the motor". Extra care, special skills and the very best insulating materials go into E. D. windings. That's why costly motor failures and down-time are almost unknown with these dependable power units. Heavy cast corrosion-resistant frames give added durability. Every motor is dynamically balanced.

Yet E. D. motors are *competitively priced!* Get all the facts before you specify *any* motor. Write today for illustrated literature.

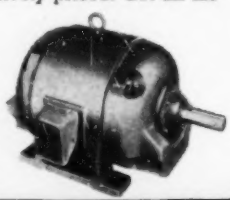
There's a Reason for Their AMAZING STAMINA



TOTALLY ENCLOSED (Fan Cooled)
...For dirt-laden atmosphere, especially where the installation requires a motor of compact dimensions.



TOTALLY ENCLOSED
(Non-Ventilated)...
For use in exceptionally dirty atmospheres, particularly when metallic dust is present.



SPLASH PROOF...For installation where the motor is subjected to splashing liquids or hosing down for cleaning.

Industry has learned what marine engineers have known since 1880

E. D. industrial motors are built in a wide range of types and sizes, 1 to 250 h.p. Also a complete line of Direct Current motors and generators. Literature on request.

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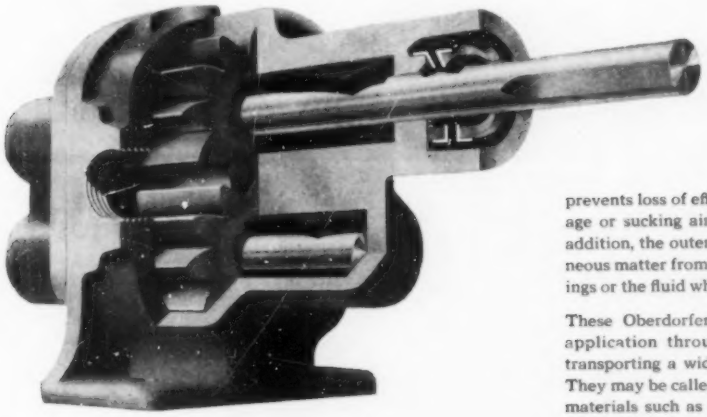

Fig. 1—Cut-away drawing of the Oberdorfer Rotary Gear Pump showing position of National Syntech* Oil Seals.

Syntech* Pressure-Type Oil Seals Increase Efficiency and Life of Rotary Gear Pumps

The minimum contact sealing lip design, common to all National Syntech* Oil Seals, offers many advantages in applications where pressures and corrosive fluids are encountered.

As compared to conventional packing glands:

1. They create less shaft drag.
2. Their Syntech* sealing members are impervious to a greater number of chemicals and corrosive fluids. (Consult our engineers about the fluid involved.)
3. They require less time and skill in installation (less cost) whether in production or in replacement service.
4. Their use simplifies machinery design.

* *Trade Mark Registered*

Fig. 2—National Syntech* 340,000 series springless oil seal.

A case in point is the Oberdorfer Rotary Gear Pump shown in cut-away drawing (Fig. 1). In these pumps a pair of National Syntech* 340,000 series springless oil seals (Fig. 2) are utilized. During the operating cycle the sealing position may be alternately subjected to pressure or vacuum, therefore, the placement of the two seals back to back prevents loss of efficiency through leakage or sucking air into the system. In addition, the outer seal prevents extraneous matter from reaching pump bearings or the fluid which is being handled.

These Oberdorfer Pumps find broad application throughout industry for transporting a wide variety of liquids. They may be called on to handle heavy materials such as molasses or low viscosity oils. Since they are universal in their application, it is important that the seals be dependable under varied circumstances. There are over fifty mechanical parts in these Oberdorfer Pumps and in some cases tolerances are held to .00025 of an inch. Shafts are of stainless steel and are micro-finished which contributes to the efficiency of the oil seals.

Perhaps you have a problem requiring "precision sealing." If so, remember National engineers may have already solved a similar problem and have a stock design oil or fluid seal immediately available for you. It will cost you nothing to investigate.

"Let Your Decision be Based on Precision"

NATIONAL OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert Ohio

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Tube Swelling Can't Happen Here

NO TUBE SWELLING... NO PRESSURE LOSS... WITH THIS SPECIAL STAINLESS STEEL INNER WIRE BRAID

Here's the special stainless steel inner wire braid that puts CONCORD #20 Steam Hose in a class by itself. The constant inside diameter assures full steam pressure at all times.

Concord #20
STEAM HOSE

Most steam hose fails for one main reason: tube swelling. But this failure will never shorten the life . . . *or lessen the dependability* . . . of patented CONCORD #20 Steam Hose.

For this hose is constructed with a special stainless steel inner wire braid that cannot swell.

This means that you will always have a full pressure flow because tube constriction can't occur.

Too, when re-coupling becomes necessary, you'll be able to do it easily, quickly, with no complications.

Other construction features of this great steam hose: alternate high tensile steel wire and rubber layers firmly bonded over the outside of the tube for maximum burst protection. Asbestos braid provides positive cover adhesion and acts as cover insulator. And the tough, abrasion-resistant cover withstands the most severe abuse.

CONCORD #20 . . . flexible, tough, dependable...is the steam hose you'll want to have working for *you!*

BWH
DEPENDABLE RUGGEDNESS

Another Quality Product of

BOSTON WOVEN HOSE & RUBBER COMPANY

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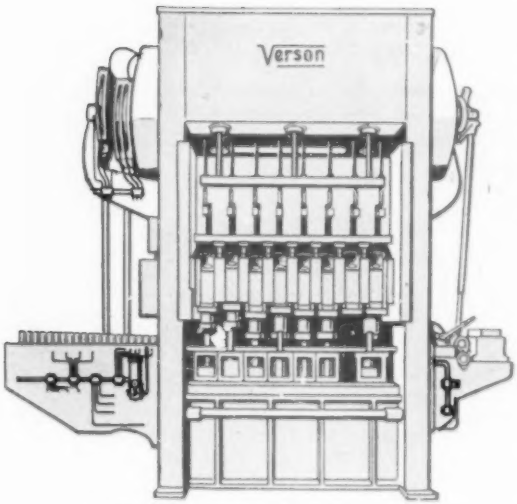
30 million stampings without a bearing failure

...thanks to Farval lubrication

FARVAL—*Studies in Centralized Lubrication* No. 123



With a few strokes of the Farval hand lever, every bearing of this big Verson Transmat Press is adequately lubricated. No stopping the machine, no time lost, and never a bearing missed.

VERSON built and installed this high-speed Transmat Press in a metal-working plant in 1946. It was factory-equipped with a Farval system of Centralized Lubrication. In the five years since its installation, the machine has never been shut down for lubrication, for bearing replacement, or, in fact, for anything other than ordinary preventive maintenance.

The press is used for progressive dieing. Coil stock is fed into the blanking station and then carried by a finger feed for several succeeding operations. It works at the rate of 22 strokes per minute. In continuous operation for five years, this press has turned out in excess of 30,000,000 stampings. By eliminating down time for lubrication and repair or replacement of bearings, Farval has contributed importantly to this impressive output—and should continue to do so for years to come.

Farval is the original Dualine system of centralized lubrication proved practical in over 20 years of service. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned.

For a full description of Farval, write for Bulletin 25. The Farval Corporation, 3279 East 80th Street, Cleveland 4, Ohio.

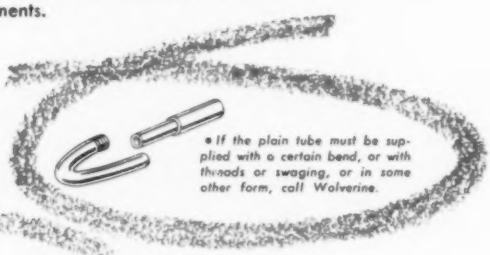
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

So now you must make something different, eh!

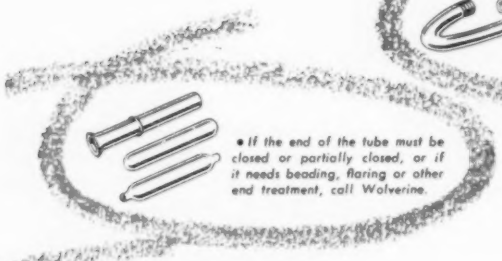
As a subcontractor you have been asked to furnish a product for the emergency. Fine. You have all the facilities to produce it, with one exception — the manufacture of one component — a tubular part — which is "a little out of your line."

So you must seek outside help. You naturally come to Wolverine Tube Division, who has had over thirty years experience in the manufacture and fabrication of tubing and has worked closely with government specifications.

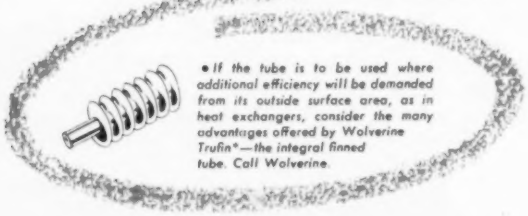
With this experience, supported by man-power and special equipment, Wolverine is ready to accept your problem with a thorough understanding of the needs of the job. You can be sure that the tubular part which Wolverine furnishes will meet all requirements.



• If the plain tube must be supplied with a certain bend, or with threads or swaging, or in some other form, call Wolverine.



• If the end of the tube must be closed or partially closed, or if it needs beading, flaring or other end treatment, call Wolverine.



• If the tube is to be used where additional efficiency will be demanded from its outside surface area, as in heat exchangers, consider the many advantages offered by Wolverine Trufin—the integral finned tube. Call Wolverine.*

Your answer to the question: "Who is best equipped to supply the tubular part I need for this D.O.?" can be found here at Wolverine Tube Division.

*Reg. U.S. Pat. Off.

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CALL FOOTE BROS.

Compact, small size units for use on original equipment—husky horizontal or vertical worm gear drives—heavy duty helical gear drives up to approximately 1000 h. p.—gearmotors. Whatever your requirements in power transmission, you will find exactly what you need in the complete Foote Bros. line.

Three large plants, containing the latest in gear cutting equipment, are backed by nearly a century of engineering and manufacturing experience. New techniques, better control of material, improved manufacturing methods—all assure superior enclosed gear drives. Check the coupon for the bulletins in which you are interested.

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LINE-O-POWER STRAIGHT-LINE DRIVES
Economical in original cost and operation. Duti-Rated Gears have file-hard tooth surfaces and ductile cores, assuring long life. Double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower.

FOOTE BROS.—LOUIS ALLIS GEARMOTORS
A compact line of gearmotors in 17 sizes in single, double and triple reductions, incorporating Duti-Rated Gears that assure long wear life and maximum load-carrying capacity. Available with Louis Allis open drip-proof, splash-proof, enclosed and explosion-proof motors.

HYGRADE WORM GEAR DRIVES
Heavy duty drives with precision worm gearing that assures high efficiency and load-carrying capacity. Horizontal, vertical and Hytop (extended shaft) types. Ratios from 4⅛ to 1 up to 4,108 to 1. Capacity up to 260 horsepower.

MAXI-POWER HELICAL GEAR DRIVES
Heavy-duty helical gear drives. Available in single reduction units, ratios up to 9.91 to 1; capacities up to 1,550 horsepower; double-reduction units, ratios from 9.32 up to 71 to 1, capacities to 1100 horsepower; triple reduction units, ratios from 79 up to 360 to 1, capacities up to 420 horsepower.

WORM-HELICAL GEAR DRIVES
Heavy duty vertical drives with horizontal input shafts and vertical output shafts—up or down. Ratios from approximately 25 to 285 to 1 and a capacity range up to 128 horsepower.

Foote Bros. Gear and Machine Corporation
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Chicago 9, Illinois

- ☐ Bulletin HGA Hygrade Worm Gear Drives
- ☐ Bulletin LPB Line-O-Power Straight Line Drives
- ☐ Bulletin MPB Maxi-Power Helical Gear Drives
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors
- ☐ Bulletin WHA Worm-Helical Gear Drives

Name ..... *Position* .....
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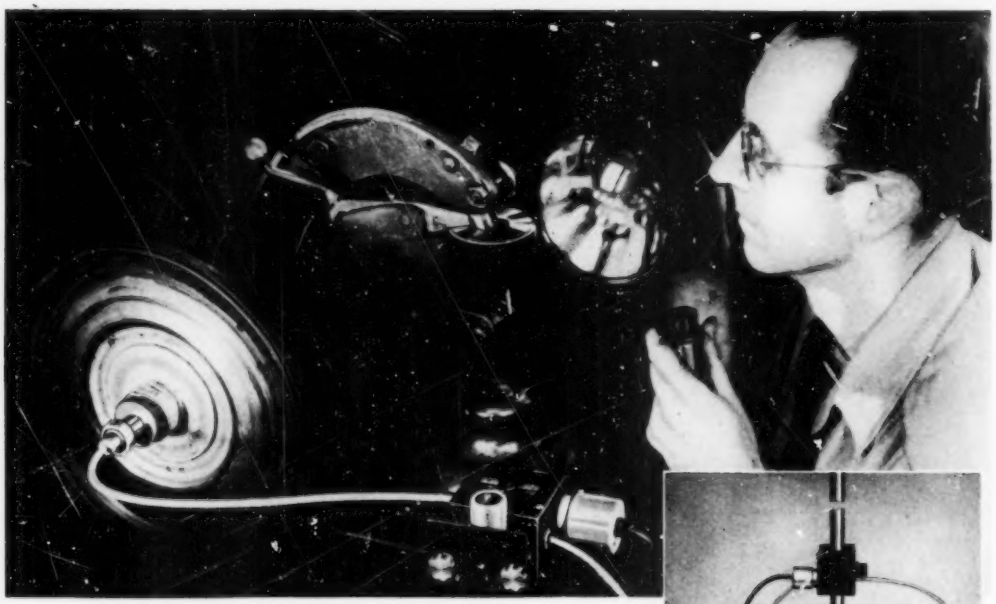
FOOTE BROS.
Better Power Transmission Through Better Gears



new Synchronizing Contactor

for the **STROBOTAC**® and the **STROBOLUME**

To meet an insistent demand from users of the General Radio stroboscopes for a versatile contactor, by means of which the STROBOTAC or STROBOLUME can be 'fired' from a mechanical contact with any rotating shaft, we announce the new Type 1535-A CONTACTOR.

This unit has a powerful magnetic clutch, on the end of an 18-inch flexible shaft, which can be attached to any shaft of magnetic-sensitive material, even while the shaft is rotating.

The rotating clutch in turn drives an electrical contactor in the housing of the assembly. The contactor automatically synchronizes with the rotating shaft. Irrespective of changes in speed, the stroboscope is always in synchronization with the rotating shaft.

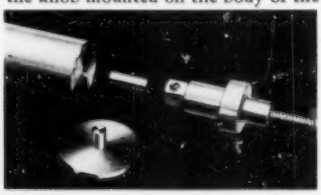
Flashes can be timed to occur at any position of the shaft, by either rotating a hand-held knob on the end of an 8-foot flexible cable, or by turning the knob mounted on the body of the contactor. The angular position of the contacts can be set anywhere within 360 degrees, the positioning scale being calibrated every 5 degrees to facilitate resetting.

There are six equally spaced contacts in the assembly. They can be connected to give combinations of 1, 2, 3 or 6 equally spaced flashes per shaft revolution.

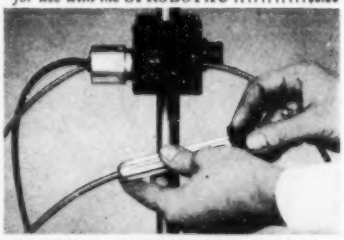
This magnetic contactor greatly increases the utility of General Radio stroboscopes in industry, providing a simple, reliable and accurate means for timing the stroboscopic flashes to synchronize automatically with any rotating shaft.

The contactor assembly can be locked in position at any point on a 4-foot upright mounted on a heavy cast-iron base. The range of height adjustment is 6 inches to 4 feet; or the assembly can be removed from the stand and mounted permanently on a machine.

Type 1535-A Contactor **$140.00**
Type 1535-P1 Adapter Cable
for use with the STROBOTAC **$5.50**



The accessories shown above are supplied with the Contactor. The steel disc in the foreground is used when the magnetic clutch is to be attached to non-magnetic or small shafts. The short rod can be fitted into a hole drilled in the shaft so that the screw-set coupling can be attached to the shaft for permanent or semi-permanent set-ups.



By rotating the knob held in the hand (above) or the knob on the contactor housing, flashes from the stroboscope can be made to occur at any position of the rotating shaft. For resetting purposes the position of the contacts is indicated every 5 degrees on a 360-degree scale.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

See Actual Demonstration

•

Metal Show
Detroit
October 15-19
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Space 357

You can CUT Assembly TIME and COSTS *and improve product performance*

Eaton Springtites (Reliance Helical Coil Spring Lock Washers pre-assembled on bolts or screws so they rotate freely under tightening torque and can't come off) and Sems (multi-tooth washers similarly pre-assembled) save five or more motions in bolting assemblies — reducing assembly time and costs correspondingly.

• Of added importance—they provide complete nut thread engagement and full-nut bearing to insure against "pull through" and thread damage.

• The non-fatiguing spring steel sections of the washers also keep bolted assemblies on your product *tighter longer*, safeguarding your reputation and maintaining customer good will.

• Your nearest Eaton-Reliance sales office will be pleased to show you just how much you can save with Eaton Springtites and Sems.

Springtites and *Sems*

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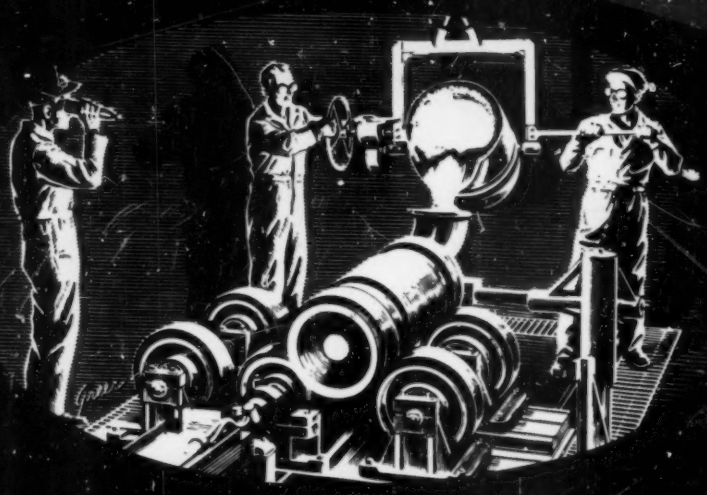

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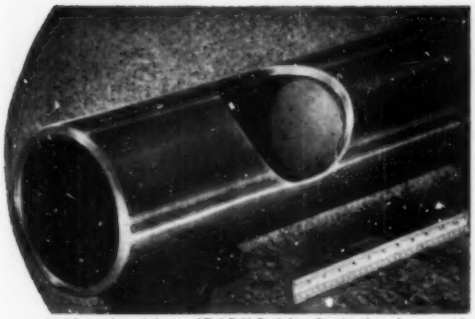
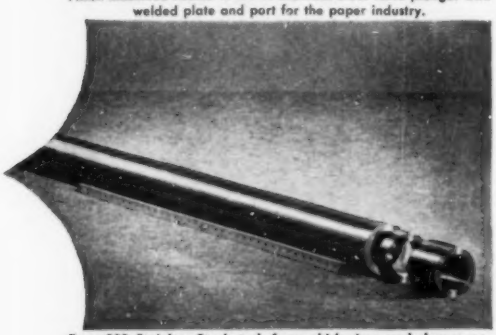
AMERICA'S LARGEST PRODUCER OF CENTRIFUGALLY CAST FERROUS METAL PRODUCTS IN TUBULAR FORM

portrait!

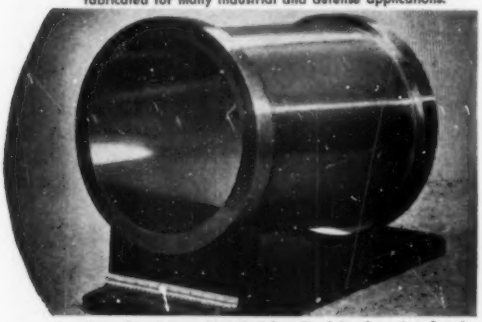
METAL MOLD CENTRIFUGAL CASTING SPELLS ECONOMY AND EFFICIENCY FOR WIDENING GROUP OF STAINLESS STEEL PRODUCTS



Finish machined Armco 17-4 P H Stainless Steel valve plunger with welded plate and port for the paper industry.



Type 303 Stainless Steel stock from which rings and sleeves are fabricated for many industrial and defense applications.



Rough machined Type 316 Stainless Steel bowl casting for the food and processing industries.

Pictured here are a few of the many stainless steel products now included in the rapidly increasing family of products centrifugally cast for industry by our new metal mold process.

This method offers many specific advantages. For one, centrifugally cast stainless steel cylindrical sections, formed by pouring molten metal into rapidly spinning, refractory-coated permanent metal molds represent the ultimate in casting quality, imparting a fine, dense grain structure, unusually free from conventional casting defects.

You may find that your stainless steel product can be cast more advantageously by this versatile process. Our engineers will be glad to answer any of your questions.

SIZE RANGE AND COMPOSITION FLEXIBILITY

Outside Diameter — 4" to 30"

Wall Thickness — $\frac{1}{8}$" and up

Length — Up to 14' in the "as-cast" condition

Types of Stainless Cast — All standard AISI and ACI grades of ferritic and austenitic stainless, plus "Special" types

CHECK THESE ADVANTAGES FOR YOUR CYLINDRICALLY-SHAPED PRODUCTS:

- Reduced Processing Time and Increased Production.
- Minimum Scrap Loss.
- Design of parts to suit the specific job requirement by selecting the correct alloy — not the next best available alternate.
- Conservation of critical metals and alloys — especially on tubular parts now produced from solid sections.

DIE CASTING filters out production bugaboos

Eddington 5-254 Fuel-Oil Filter, die cast from aluminum by Mount Vernon

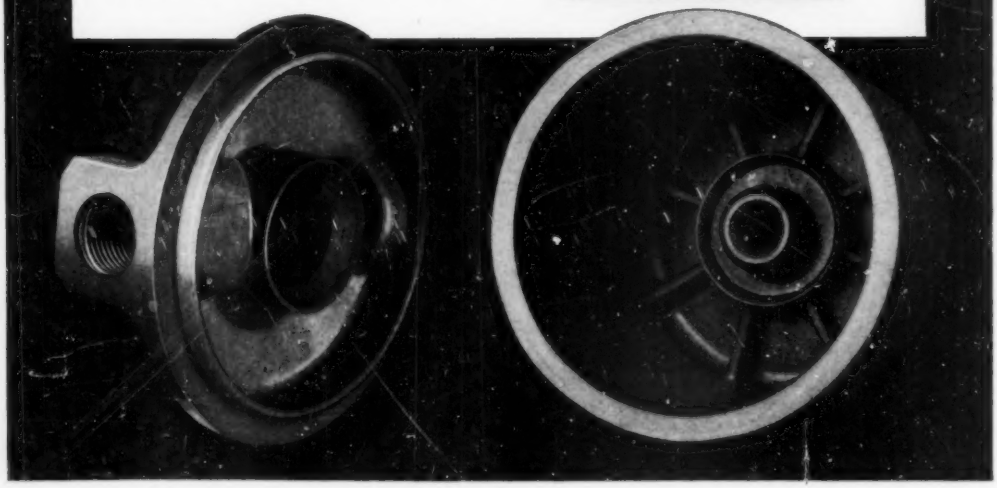
CASE HISTORIES FROM MT. VERNON FILES

Too many operations; too many man hours; too much waste of materials. These are the bugaboos that tend to plague every production line and raise unit costs. But with die casting, you can filter them all out—simplify and speed production while conserving every possible ounce of material.

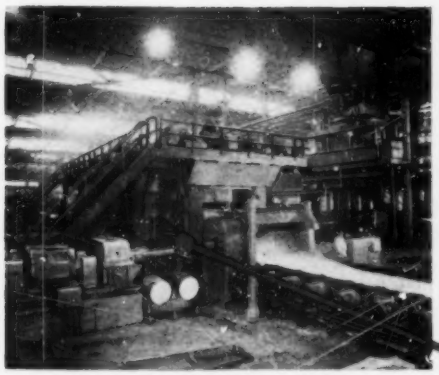
The Eddington Fuel-Oil Filter shown here is die cast by Mount Vernon in two pieces, a cartridge container and cap that make perfect oil-tight fit. Note the built-in cartridge seat with single bolt construction, and the flanges that give strength to the base of the container while providing a spacious sludge and water sump. Also the inlet, outlet and cartridge-retaining elements integral with the cap. Every feature is produced simultaneously and instantly, as the die closes . . . and so "clean" that subsequent machining is virtually eliminated.

Says Eddington Metal Specialty Co. of Eddington, Pa.: "Our specially engineered filters for heating oils are die cast, because die casting gives a superior product over other possible methods of manufacture—proves most economical—gives volume output in minimum time—reduces the need for machining to a minimum."

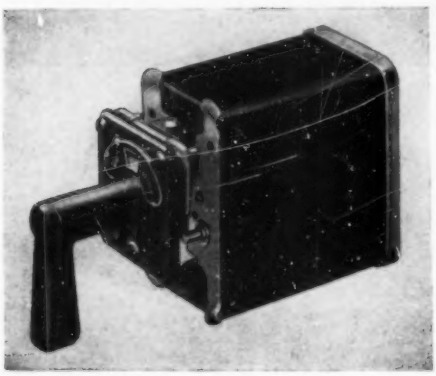
And Eddington's experience is repeated again and again in a host of applications in different fields. If you have not already profited from the many advantages inherent in die casting, why not utilize this versatile, cost-cutting medium? We shall be glad to put our wealth of experience at your disposal, and make recommendations based on your specific needs.



Versatile switch simplifies control of huge hot strip mill



86 in. Hot Strip Mill, Kaiser Steel Corporation



Another job made easy by G-E

SB CONTROL AND TRANSFER SWITCHES

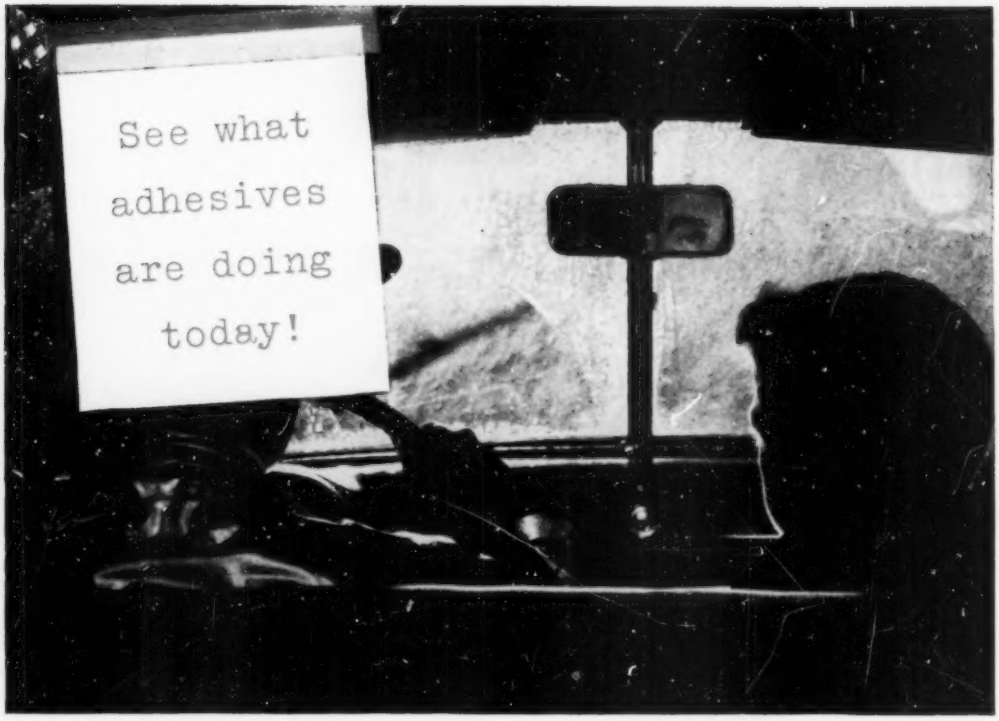
RED HOT STEEL STRIP races at nearly 1500 feet per minute from the big mill of the Kaiser Steel Corporation at Fontana, California. Precision control of speed, tension, width, thickness and the flying shear which cuts the steel "on the run" requires many circuit-sequence combinations. Sturdy General Electric SB switches provide the necessary versatility and assure reliable performance.

THIS IS JUST ONE EXAMPLE of the thousands of control installations made easy with the compact, versatile family of SB-type switches. By varying the cam and finger arrangements and number of stages, design engineers have utilized the General Electric Sb-1-type switch, for example, with over 10,000 circuit-sequence control combinations. Standard parts and simple basic design mean long life and dependable operation.

FOR FURTHER DETAILS see your G-E sales representative, or write for Bulletin GEA-4746, Section 856-76, General Electric Company, Schenectady 5, N. Y.

856-70

GENERAL ELECTRIC



Mastering motor-made hurricanes

Did you ever stop to think that when you drive 60 miles per hour in a rain storm, the rain is hitting your windshield with almost hurricane force? Mastering these motor-made hurricanes is another specialty of 3M adhesives and sealers.

Sealing an automotive windshield requires outstanding performance from any sealer. It must bond the glass securely to rubber. The sealer must stand up under hot summer sun and zero winter cold. It must be impervious to moisture, and neither swell nor shrink under all driving conditions. By performing this exacting job on your car, a 3M sealer assures you of driving comfort the year around.

Making top-quality adhesives, coatings and sealers that successfully meet such tough requirements is 3M's specialty in the adhesives field!

See what adhesives can do for you . . .

Many manufacturers have found that adhesives aid in product improvement. Contact your 3M field engineer. He will be glad to examine with you the possibilities of adhesives in your business. Or, write directly to 3M, Dept. 410, in Detroit.

3M COMPANY

OVER 1,000 BASIC

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ADHESIVES AND COATINGS DIVISION • MINNESOTA MINING AND MANUFACTURING COMPANY

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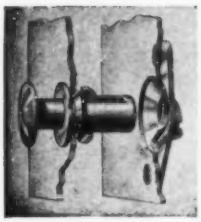
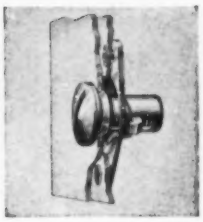
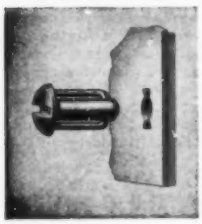
MINNESOTA MINING & MANUFACTURING CO. OF CANADA LTD., LONDON, CANADA

3 ways to save on assembly costs

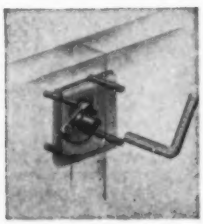




QUICK-LOCK For fastening removable access doors and panels. Because of its ease of installation, QUICK-LOCK is ideal for assembling removable panels. A 90° turn locks it in place. Stud is self-ejecting when unlocked; visual inspection shows whether fastener is locked. Spring loading takes initial load; solid supports carry increased load. Available in a wide range of sizes.



SPRING-LOCK One-piece fastener for blind holes has load-carrying steel spring wire. Spring steel arms lock fastener securely, prevent loosening under vibration. SPRING-LOCK will work with varying panel thicknesses, locks with a twist of the wrist. SPRING-LOCK is now available in high-impact plastic. The molded design permits heads to be made in various shapes for refrigerator shelf supports, washer knobs, brackets. Available in a wide variety of shapes and sizes, and also in custom designs.



ROTO-LOCK Serrated, tapered cam is engaged by formed lug as fastener is locked. Cam action draws panels together tightly, insures locking even under conditions of misalignment. Opens easily for demounting. ROTO-LOCK carries heavy tension and shear loads; can be used for air and water-tight seals; recesses completely into panels. Solidly built without springs or delicate mechanical parts, unaffected by arctic temperatures or field service.

Simmons Fasteners are widely used in refrigerators, washing machines, electrical equipment, electronic assemblies, prefabricated portable shelters, coolers, demountable furniture. Every Simmons Fastener is a service-proved design with a long record of assembly-cost saving in many industries.

If you are interested in cutting your costs, turn to Simmons Fasteners—the fasteners with *uses unlimited*. Write for samples and catalogs today.

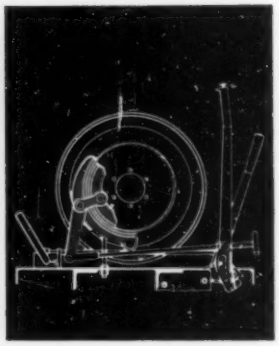
SIMMONS FASTENER CORPORATION
1751 *North Broadway, Albany 1, New York*

Simmons
QUICK-LOCK
SPRING-LOCK
ROTO-LOCK

A Problem of Speed Plus Accuracy—

SMOOTH, RESPONSIVE BRAKES

GIVE POSITIVE CONTROL!



Because of the need for accurate and dependable control of rotation speeds under severe weather and working conditions, a TDA Duo-Grip Brake is standard equipment on the Halliburton Measuring Reel. The machine lowers a wire measuring line and instruments into oil wells at speeds up to 1,100 feet per minute. The manufacturer states: "This brake gives good braking effect with little effort on the brake lever without sacrificing sensitivity and accurate control." Some have been in service for three and one-half years without relining—a clear indication of their excellent performance!

WHATEVER *YOUR* BRAKING PROBLEM— TAKE IT TO TDA BRAKE DIVISION!

It's hard to think of a more important factor of machine operation than *control.* When the rotation of equipment must be retarded for a time—or brought to a full stop—this matter of control becomes a task for efficient, properly designed brakes. That is why more and more machine manufacturers are turning to TDA Brake Division. Backed by more than 40 years of concentrated experience in the field, thoroughly qualified specialists are available to analyze your brake needs and to supply equipment precisely engineered for your specific purposes. TDA Brakes can improve your product's performance and reduce your customer's maintenance expense. Mail the coupon below—*today!*

Here Are A Few Of The Many Products Which Can Be Equipped With TDA Brakes

Centrifuges • Compressors • Conveyors • Cranes Cream Separators • Diesel hook-ups • Dry cleaning machinery • Extractors • Hoists • Industrial electric trucks • Lathes (automatic) • Looms (textile) • Lumber mill machinery • Machine tools • Materials handling equipment • Motors • Packaging machinery • Paint mixers • Press brakes • Printing presses • Rolling mills • Shears • Warpers (textile) • Welding positioners • Winches • Automotive • Farm equipment Earth moving equipment • Construction equipment Public transportation

IF IT ROTATES WE CAN BRAKE IT

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ALUMINUM REPORTER

★ ★ ★ Seventh in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

HEAT-TREATABLE ALUMINUM EXPANDS USES

Aluminum Pipeline in Use 1½ Years Shows No Corrosion

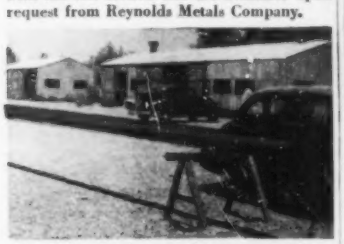
Recent uncovering of the 40-foot bare aluminum by-pass installed approximately eighteen months ago in the Alabama-Tennessee Natural Gas Company's 8-inch aluminum pipeline revealed absolutely no discoloration or corrosion of any sort.

Unretouched photograph showing aluminum pipeline section after seventeen months underground.

This section of pipe was installed without any protective coating or wrapping to test the natural corrosion-resistance of aluminum.

Careful inspection both inside and outside was made to determine any sign of wear or corrosion. No corrosion of any type could be found on the outside, where the bare pipe was in contact with the soil; nor on the inside, which carried natural gas. The test period was approximately eighteen months.

Supervised by officials of the gas company and Reynolds, this inspection showed that aluminum pipe would last indefinitely under such conditions. Soil analyses were taken along with the test section and are available upon request from Reynolds Metals Company.



Aluminum pipeline after being removed from ground. Note absence of corrosion in this unretouched photo.

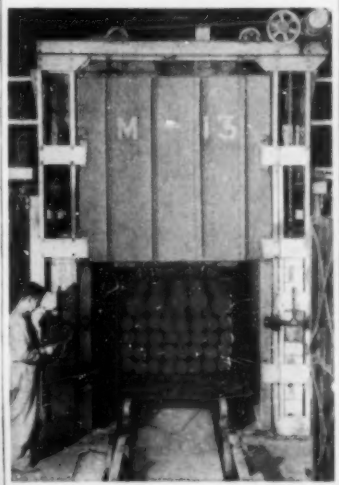
For further information on how the adaptability and corrosion resistance of aluminum can be applied to your product or problem, contact the Reynolds office or distributor listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Four Part Book Has Valuable Information for Both Non-Technical Men and Metallurgists

Until recently, little information has been available on methods of heat treating the aluminum alloys. There has been a great need for this information since aluminum has become one of America's foremost metals.

The improved strength, hardness and temper of heat-treatable aluminum, especially the comparatively new 75S alloy, have greatly expanded the use of this lightweight metal in almost all industries. Now aluminum can be used in more places and for more purposes than ever before.

A 144-page illustrated book, "Heat Treating Aluminum Alloys," that brings together all the latest information on the subject in a form readily usable by both the non-technical man and the highly trained technician is now available from the Reynolds Metals Company.

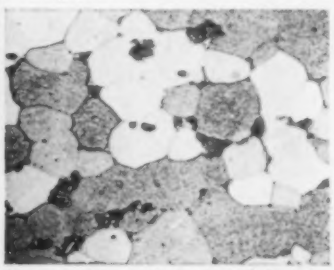


A 30,000 pound soaking furnace for handling billets. Note connections to thermocouples imbedded at various points in the load.

The book was prepared with the assistance and collaboration of some of the country's leading metallurgists and organizations. It contains photomicrographs, like the one in the column at right, showing the crystal structure for various treatments and alloys.

Divided into four parts for ready understanding and use, the book is handy for both desk and shop reference. Section One breaks down the subject into easily understandable concepts for the non-technical reader. Section Two presents in brief tabular form the recommended heat-treating cycles for specific aluminum alloys. Section Three is a technical discussion of the various treatments, possible difficulties and their cure. Section Four contains tables of mechanical properties for both wrought and cast alloys.

Application of the methods described in this book can improve the quality of your product and mean more profit for you through fewer rejects.



Structure of incorrectly heat-treated aluminum alloy R301. Excessively high temperature resulted in melting certain constituents at grain boundaries. Kellers etch. 500 X.

And if you have a *special problem* on design or fabrication with aluminum, take advantage of the trained staff of Reynolds Aluminum specialists waiting to help you. For prompt service, call the Reynolds office or distributor listed under "Aluminum" in classified telephone directories.

(Instructors are invited to request copies of this book for their senior and graduate engineering students. A 24-page condensation is also available without charge to other students.)

For your free copy of the valuable handbook, "Heat Treating Aluminum Alloys" plus a complete index of Reynolds technical literature, request today on business letterhead (otherwise price is $1.00). Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE INTERESTING NEWS ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

Printed in U. S. A.

(Continued From Preceding Page)

Roll-Formed Sections Ideal for Many Aluminum Applications

The continuous process of cold roll-forming aluminum into sections of various shapes is one of the valuable services made available to manufacturers by Reynolds Parts Division.

In many assemblies, the use of long roll-formed sections results in more efficient operations and a considerable scrap saving. Accuracy of roll-formed parts is usually maintained more closely than that of parts produced by other forming processes, thereby promoting interchangeability. Clear smooth finishes are easily obtained by roll-forming.

These advantages have been found to be of tremendous value to users of mouldings, structural parts, angles, channels, hat sections, zees, butt seam tubing, lock seam tubing and many miscellaneous shapes.

Among these users are manufacturers of automobiles, railroad and marine equipment, busses, trucks, trailers, aircraft, farm and ranch gates, clothes dryers, scaffoldings, ladders, screens, storm sash, television antennae, masts, siphon tubing, building products and many others.

For example, the Reynolds Fabricating Service furnishes roll formed hat sections to the Alprodco Company of Mineral Wells, Texas. These sections are the basis for an all-aluminum ranch and farm gate sold in great numbers by this company throughout the West. The sections are used for vertical, horizontal and diagonal members of the gate.

This is only one example of the valuable service made available to manufacturers through the use of the Reynolds Parts Fabricating Service. Formed or partially formed parts are delivered to the manufacturer ready for finishing and assembly, resulting in scrap savings averaging 30%—often as high as 75%—plus valuable time savings.

Reynolds Parts Fabricating Service is a complete service with equipment for shearing, forming, drawing, tube bending, roll-forming, roll shaping, riveting, welding and finishing. The Service is set up to work with all manufacturers, regardless of size, to secure coordination of all resources to expand the nation's production capacity on defense orders.

For complete information on how the Reynolds Parts Fabricating Service can help you, write for the free booklet, "Pounds of Parts . . . instead of Pounds of Metal." And for assistance on your particular requirements, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write Reynolds Metals Company, 2065 South Ninth Street, Louisville 1, Kentucky.

Be sure to see our booth, F-325, at the Metal Exposition—Detroit, October 15-18. We'll be pleased to answer your aluminum design or fabrication questions—and show you a host of aluminum improved products.

Aluminum Pigments Offer Variety of Finishes For Beauty, Protection and Durability

If your product cannot be made of aluminum, the next best thing is to take advantage of one of several attractive aluminum finishes.

When mention is made of aluminum paints, the usual thought is of the bright, silvery surface most often seen in "leafing" type paints. But there are other types of aluminum pigment finishes, chief among which are the "wrinkle," "hammered metal" and "polychromatic" types.

The "wrinkle" type is widely used for an attractive, glare-free finish on such objects as typewriters and other office machines. This finish is produced by coating the metal with a special opaque paint to which "non-leafing" aluminum pigment has been added. The wrinkled effect is achieved by a short baking operation. Advantages of this type of finish are the glare-free surface and defect-hiding properties. Minor surface scratches are hidden without buffing.

The "hammer" type finish, so called from its resemblance to the effect achieved by light tapping on metal with a ball-peen hammer, is widely used to obtain a smooth, easily cleaned surface with multi-colored effects on such objects as thermos jugs, ashtray stands, automatic vending machines, lawn mowers, etc. This finish will also cover minor surface defects. The "non-leafing" aluminum pigmented paint is formulated in such a manner that, having been sprayed on the object and left to dry, the paint automatically produces a "crater" or "hammered" effect.

The third finish, widely used for its lustrous beauty, is the "polychromatic" coating. This finish is in great demand for automobiles because of the added durability and beauty imparted by the reflective aluminum pigment. "Non-leafing" aluminum flakes remain suspended in the transparent color lacquers or enamels giving a metallic iridescence. Examples of this type of pigment finish are the sparkling, jewel-like colors you see more and more on the late model automobiles. Polychromatic effects are also favored for plastic materials such as shower curtains, chair-coverings, raincoats, etc.

To learn more about these attractive and durable finishes, call the Reynolds office listed under "Aluminum" in your classified telephone directory. Or, write to Reynolds Metals Company, 2576 South Third St., Louisville 1, Ky.

Aluminum Gains in Favor for Curtain Wall Construction

The term "curtain wall" is a designation for non-structural closures for the structural frame work of modern buildings.

Curtain wall panels are prefabricated units of insulation material sandwiched between facings of plain or decoratively embossed aluminum—or aluminum for the exterior and other finishing material inside—similar to plywood but considerably thicker.

There are several curtain wall panel designs with varying methods for interlocking and sealing. A number of factory and office buildings have already employed this new construction method with highly satisfactory results.

The advantages of aluminum for curtain walls are apparent. Light weight combined with great strength, natural attractiveness and resistance to rust and corrosion make aluminum an ideal material for modern construction.

A Reynolds Aluminum Specialist will be glad to discuss all the advantages of aluminum in your products. Call the Reynolds office or distributor listed under "Aluminum" in your classified telephone directory or write to Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.

Reynolds Wrap is now "all out" for defense

Return Flight Guaranteed!

Reynolds Developing World's Biggest Bauxite Deposit in Jamaica, B.W.I.

A 40,000 to 50,000 acre tract of Jamaican real estate has been acquired by Reynolds Jamaica Mines, Ltd., a subsidiary of Reynolds Metals Company. The tract is said to contain by far the most important bauxite ore body ever discovered. *This deposit has enough bauxite to furnish the United States with low-cost aluminum for many decades.*

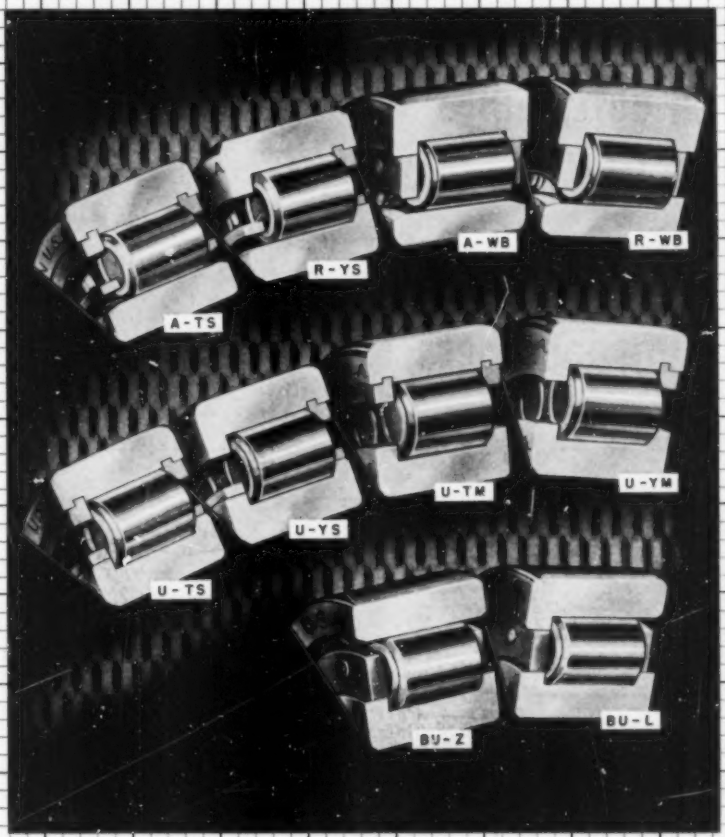
The extensive Jamaican mining project involves total expenditures of about 11½ million dollars. Construction of a pier and harbor facilities, a drying plant, overhead tramways and other auxiliary equipment is well underway and scheduled for completion early in 1952. Net result will be a reliable source of bauxite to supply the U. S. with low-cost aluminum for generations to come.

The use of low-silica Jamaican ore to supplement high-silica Arkansas bauxite will also permit the use of even lower grades of domestic bauxite than are presently regarded as usable, and will correspondingly enlarge the effective reserve.

Most of the bauxite used in the U. S. by companies other than Reynolds now is imported from Dutch Guiana, a distance of about 2500 miles. Jamaica is located only 1000 miles from Gulf ports in the U. S.

Printed in U.S.A.

(Advertisement)



HYATT HY-LOADS

The complete line of Radial Bearings

In the selection of bearings for any application, assembly methods, speed, load, life, shaft location, lubrication, and available space must all be carefully considered.

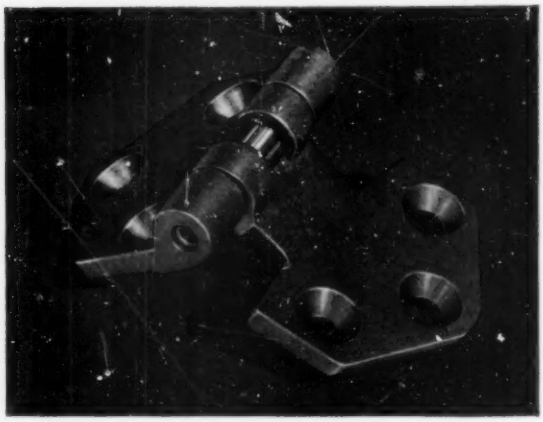
Accordingly, Hyatt Hy-Load Roller Bearings are made available in ten major types and a full range of sizes because no single bearing type nor small number of types can meet all of the wide variety of design requirements or combination of operating conditions.

* * *

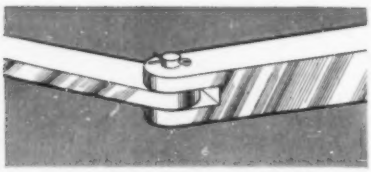
Hyatt Catalog 547, containing all the needed design data, places a wealth of bearing information at your fingertips. If you do not have a copy let us send one to you. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

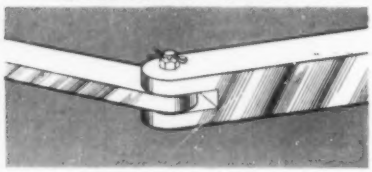
How to replace hinge pins and cotter pins with ROLLPIN self-locking fasteners

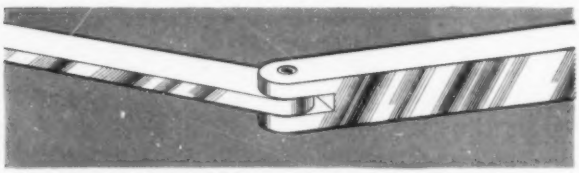


Rollpin replaces hinge pin for faster assembly of hinges. Inexpensively and simply driven in place, it cuts assembly costs. Constant spring tension holds Rollpin firm against vibration on heavy-duty automobile door hinges—on lightweight sheet metal hinges for meter or instrument panel covers.



IF YOU DO THIS ▲ *OR THIS* ▼ . . .





TRY THE ROLLPIN WAY INSTEAD . . . Rollpins offer many advantages as pivot and clevis pins for linkages or yoke assemblies. Heat-treated to provide excellent fatigue resistance and wear characteristics, Rollpins fit flush, grip firmly in the outer or inner members, depending on your design requirements, and are simply, inexpensively pressed in place. They are faster to install than cotter pins or safety wire . . . straight edges protect workers' fingers and clothing. Rollpins are readily removed with a punch . . . can be used again and again . . . assure simplified maintenance.

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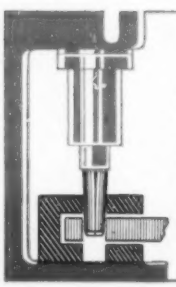

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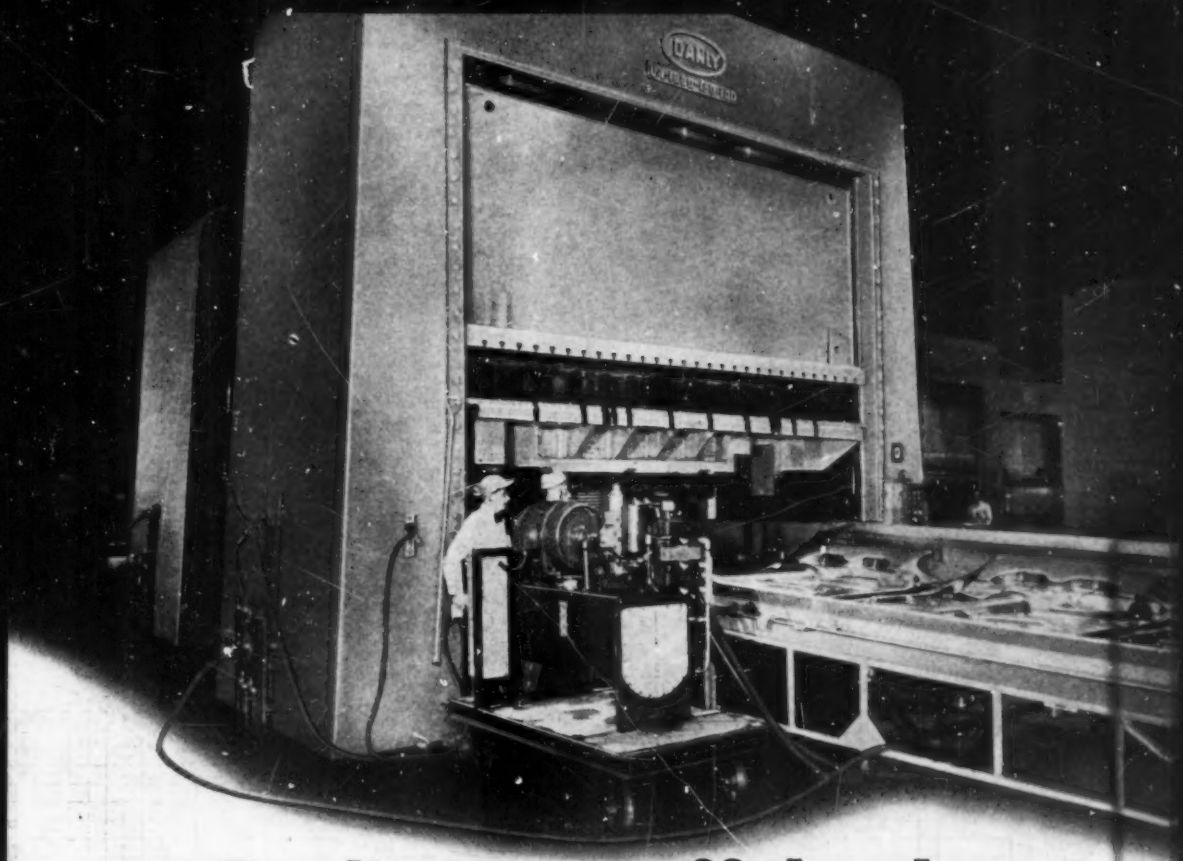
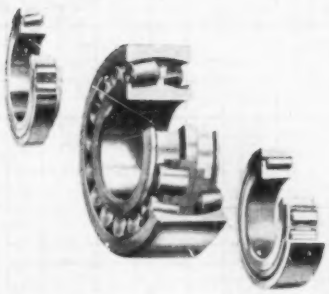


at Ford's new Buffalo plant

...Danly Presses are Torrington Bearing-Equipped



At the Ford Motor Company's new Buffalo plant, several Danly Underdrive Presses—ranging from 600 to 1000-tons capacity—are producing stampings for Ford, Lincoln and Mercury cars. In each press, nine Torrington Bearings team up to deliver smooth ram power and help reduce press downtime.

Spherical, Tapered and Radial Roller Bearings, and NCS Type Needle Bearings, are used in the driveshaft assembly and intermediate gear driveshaft of the new presses, which embody the latest developments for high-speed production and easy maintenance.

Why not include the advantages of Torrington Bearings in *your* equipment. Our engineers will be glad to help you.

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TORRINGTON BEARINGS

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE • NEEDLE ROLLERS

The experience of countless users of electric motors prove conclusively that Klixon Protectors keep motors from overheating and burning out.

Built-in by the motor manufacturer, the Klixon Protector stands constant guard, always ready to prevent the motor from burning out by cutting "off" the power just before the motor becomes dangerously overheated. Tnen when it cools to a safe operating temperature, the Protector snaps the power "on" again on the manual reset type when the red button is pushed; and automatically on the automatic reset types.

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As a user of electric motors, you can keep production moving, cut down motor upkeep to a minimum by ordering and using motors with built-in Klixon Protectors. The additional cost is low — pays for itself in short order.

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Division of Metals & Controls Corp.

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Dependable!

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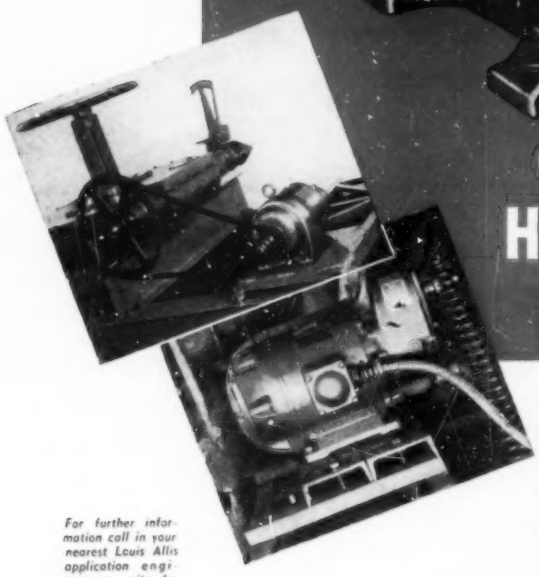
LONG LIFE



Typical examples of the many Foote Bros.-Louis Allis Gearmotors now in service. These compact Gearmotors are available in a wide range of sizes from 1 through 75 H. P. with Open, Drip-Proof, Enclosed, Splash-Proof and Explosion-Proof motors.

For further information call in your nearest Louis Allis application engineer or write for Bulletin No. 1000.

THE LOUIS ALLIS CO.

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UP TO 93% over-all operating efficiencies!

QUIET... vibrationless!

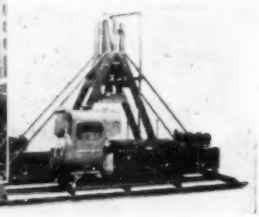
ADAPTABLE to an infinite variety of loads and speeds!

For the finest in modern power pumps, you'll want the new Blackhawk P-237. Here's a 6-piston, wobble plate design with a 15 hp maximum intermittent capacity.

As for economy — you pay no premium for the advantages offered by the P-237. Compactness and over-all efficiency spell important design savings for your equipment. And operating and maintenance costs go down.

Performance? For example, you can deliver 3 gpm at 1350 rpm and 6000 psi . . . *with only 11.65 hp input.* And long life at unsurpassed efficiencies is assured by husky anti-friction bearings. You'll want full facts on these and many other features.

A bank of three P-237 Blackhawk pumps make up the "hydraulic heart" of this famous Bucyrus-Erie "Hydro-Crane." Blackhawk valves give finger-tip control of boom, hoist line, clam-shell jaws and outriggers.



Two P-237 Pumps (along with Blackhawk control valves) are used on this 100-ton G. T. Bynum Co. oil field pipe straightener for pipe up to 16 in.

ALREADY SUCCESSFULLY APPLIED on rugged equipment of leading manufacturers

Following are typical installations of the P-237 Pump:

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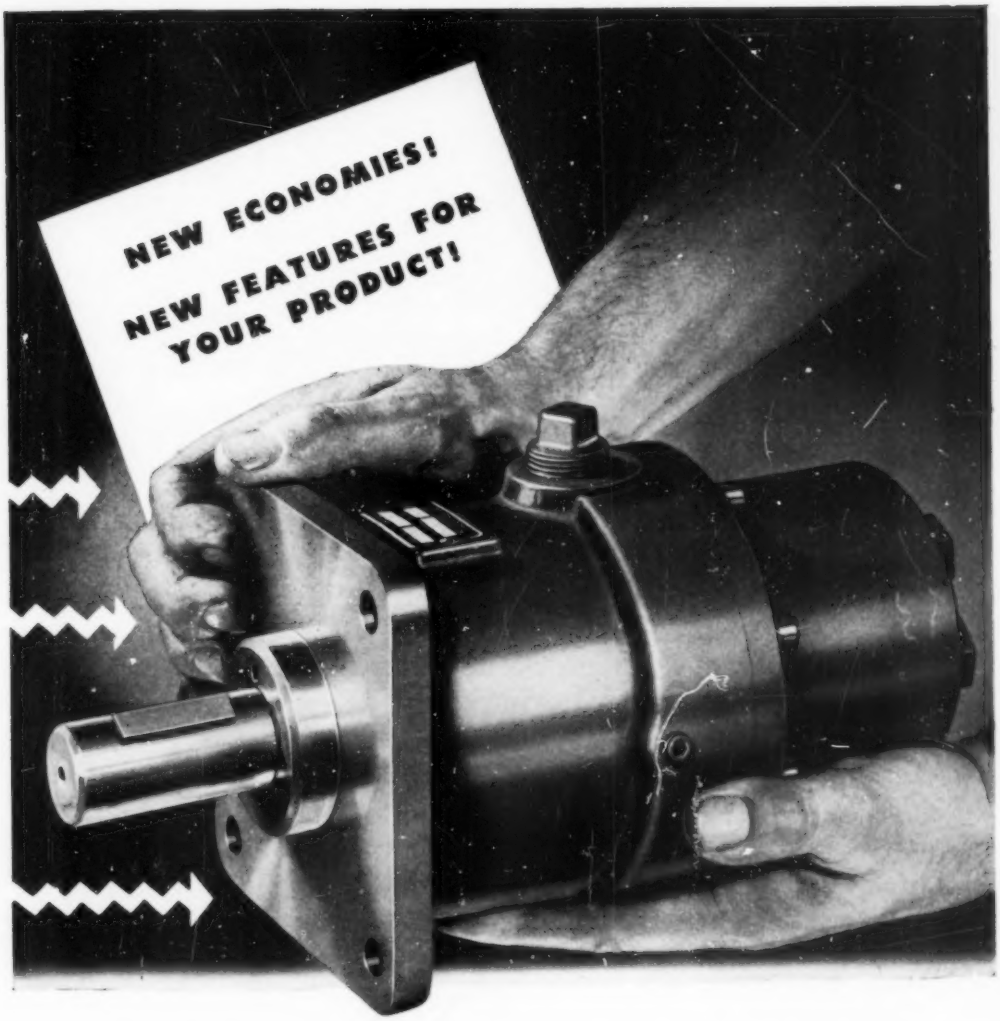
Bulldozers	Mining Machinery
Loaders	Hydraulic Presses
Trench Diggers	Materials Handling Equipment
Scrapers	Test Stands
Road Graders	Farm Implements
Dump Trucks	Tractors



BLACKHAWK

MOBILIZATION NOTE:

If you are producing or quoting on a DEFENSE PROJECT *requiring hydraulic components* — remember Blackhawk is a veteran in meeting government specifications . . . will fulfill complete responsibility for you — including cost analysis and engineering development if needed. This experience is at your service.

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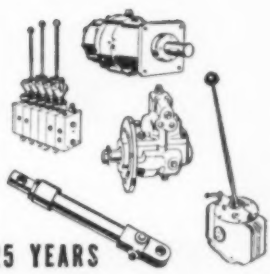
to write for Bulletin 3-B on Blackhawk "Hydraulic Pumps, Rams and Valves" as well as for Bulletin 2-P on the new P-237 Power Pump. Blackhawk Mfg. Co., 55[illegible] W. Rogers, Milwaukee 1, Wis.



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GENERAL MANAGER OF SALES

October 1, 1951

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WASHINGTON STEEL CORPORATION

John C. Richards

John C. Richards,
General Manager of Sales

Materials ~ AVAILABILITY AND TRENDS

INDUSTRIAL COMPONENTS

Industrial components which depend on copper are going to be scarcer in the fourth quarter, and next year.

Components which depend on alloy steels will be scarce--but no worse than they are now. Carbon steel components may be more plentiful. The reason is not so much an increase in steel supply, as the impact of the full controlled materials plan. CMP directives are expected to divert more steel to components than has been available up to now. This will show up in finished components the first quarter of next year. The general components division gets NPA's biggest single allocation of copper--larger even than the electrical equipment division. General component's allocation in the fourth quarter was eleven percent less than the third quarter--a cut of almost 10,000 tons. That measures the general downward trend. The recent strike trouble won't help any.

Military needs won't hit a peak until late 1952. As a result, the general components division is not cheerful about prospects for holding even its reduced fourth quarter allotment.

DIRECTIVES WILL HELP

Steel directives will help components makers by specifically ordering mills to make as much of a product as is necessary to fill all rated orders. Hot rolled bars, for example, have been extremely short. The thirty-three companies that cold-finish them for components manufacturers have often been unable to get sufficient supplies. Now their needs are figured in to a general directive to steel producers. They should be able to get full delivery on their orders. The first directive on behalf of cold finished bar producers will take effect in October.

Warehouse supplies of steel are going to be increased-another break for many components makers. Mills have been delivering at least eighty-five percent of a 1950 base period to warehouses; NPA will increase the minimum to 100 percent of the base period. This will mean about 2,000,000 tons of additional steel for warehouse customers.

ELECTRIC MOTORS

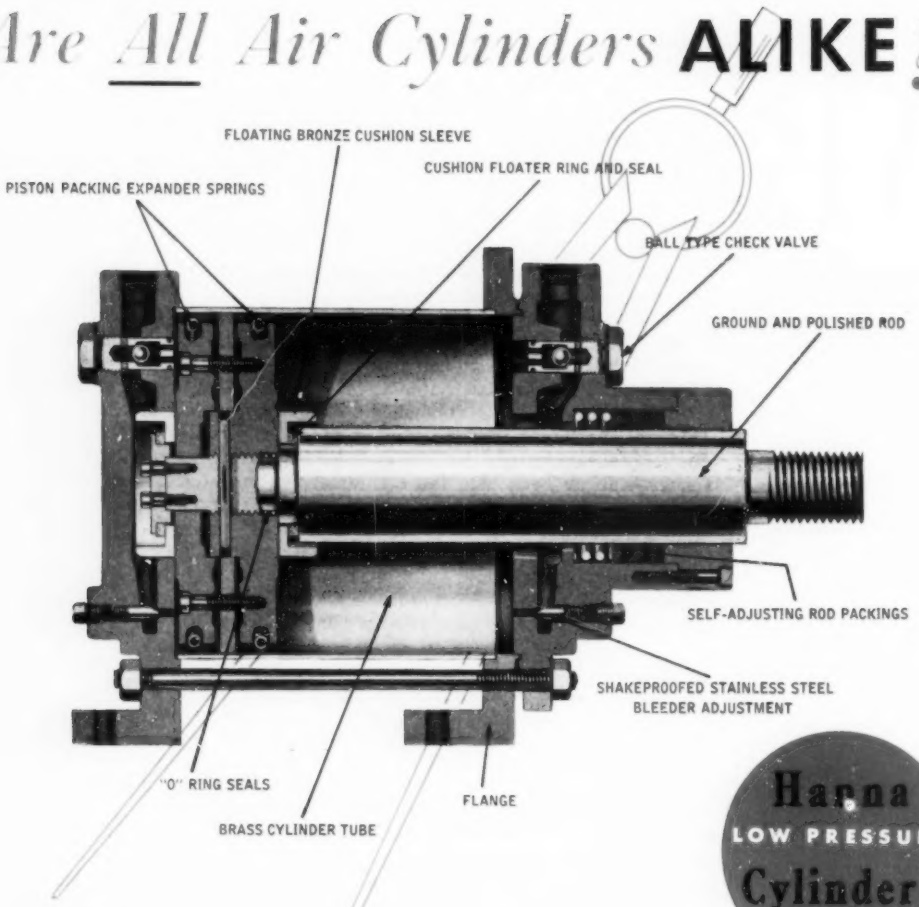
Under NPA rules they are assigned to the electric equipment division. As a whole, the electric equipment division did better regarding copper for the fourth quarter than the general components division. Instead of a cut, it got 8,500 tons more. Electric motors got enough of this to hold allocations to the third quarter level. This means present production will be maintained until next year at least. Eighty-five to ninety percent of orders have been defense-rated and the amount has been increasing. Under the complete CMP as it will take effect in the fourth quarter, all orders will be rated, of course--those from consumer durables makers as well as those from weapons makers. Lead-time on orders is running from two years for heavy motors for steel mills to three months for small sizes. The delay is due to materials shortages--there's plenty of capacity.

STOCK GEARS

Material is the key factor here, too, though machine load crops up as a short-run bottleneck occasionally. Gear makers got only seventy-five percent of their fourth quarter requests for carbon steel. Worm gears are hard hit by the alloys shortage.

(continued on page 119)

Are All Air Cylinders **ALIKE?**



Hanna LOW PRESSURE Cylinders

Not when it comes to cushion sleeves, flange design or the packing of pistons and piston rods. Each of these elements of the Hanna low pressure cylinder provides special benefits for you. Notice the expander springs which insure uniform contact of piston packing with cylinder; the cork floater ring facilitating cushion alignment with head and insuring a seal during cushioning; the spring-backed chevron rod packings, self-adjusting for consistently correct compression; the flange design permitting removal of front head without disturbing mounting. These Hanna-engineered features are refinements resulting from fifty years' experience in design and application of pneumatic and hydraulic equipment. To you they mean increased efficiency—decreased maintenance.

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FASTENERS

Production of tubular and split rivets is still running well below the 900-million pieces produced monthly toward the end of last year. Production was down to 500-million pieces a month last spring; it has climbed some recently. Shortage of rods and wire is the problem. Directives will help in the fourth quarter. Copper is the problem in non-ferrous bolts, screws and other fasteners. Cold finished bars for carbon steel fasteners have been hard to get, particularly for those who buy in less-than-mill quantities. In general, capacity is believed adequate to meet demands. Officials think the production trend will be up for fasteners made of carbon steel as directives take hold of mill production.

COLD ROLLED FORMED SHAPES

Structural shapes will remain a severe shortage, with no likelihood of relief until after the second quarter of next year. About half of structural shapes produced are going for industrial rather than construction purposes due to the impact of heavy military production and such defense supporting programs as freight cars and barges. Washington officials expect an easing of the supply of strip and sheet next year; capacity is up thirty per cent over 1948. CMP controls should smooth out the problem of getting flat rolled steel for punch-press production by the first quarter. The big part of this output which winds up in consumer durable products will be getting full CMP assistance by that time. The military demand for steel plate is still mounting; no relief from this shortage is in sight. It is one of the worst and will probably stay that way all through the mobilization period.

BEARINGS

Some shortages trace back to lack of capacity as well as to scarcity of materials. Facilities to produce very small ball bearings, for example, are inadequate. A special study was made by NPA in June which turned up this and other capacity bottlenecks in the industry. Scarcity of materials is the most common complaint, however. The trend is toward even greater shortages. The full impact of military demand will not be felt until the first half of next year, with little by way of increased capacity or materials supply to brighten the picture. Prime contractors, faced with a scarcity of precision type ball bearing in this country, are being encouraged by the three military departments to place orders for ball bearings with European manufacturers.

Orders for European bearings may be placed through U. S. bearing manufacturers, importers or directly with European manufacturers, the Defense Department said. Within three to four months after placement of orders, the survey showed, European companies will be able to supply instrument type ball bearings.

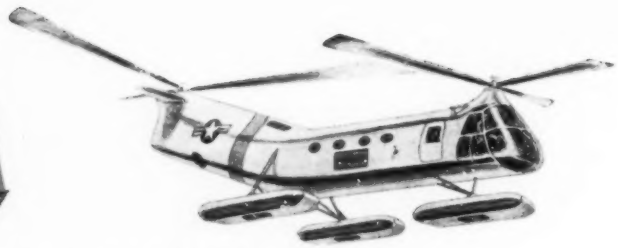
COUPLINGS

Aluminum couplings with capacities of 3/4 hp to 50 hp at 1750 rpm, in sizes 7 in. to 11 in. require approximately five months lead time. The problem is primarily production capacity. Volume will be increased as of December, but when the ceiling on materials will be hit is hard to say. It is impractical to change to steel because of added cost of fabrication.

Steel couplings range from 12 in. to 27 in. in size and 50 hp at 1700 rpm to 700 hp at 1350 rpm. These are primarily internal combustion types. Lead time on these is about seven months. Delivery on non-rated orders still obtainable, but rated order gets preference.

TORQUE CONVERTERS

Torque converters, ranging in size from 50 to 100 hp, require about 9 to 12 months lead time, depending on size. Added load has been put on manufacturers by the opening up of heavy-duty, off-highway truck business. The oil industry has been a heavy user in the past, but is now tapering off.



"Flying Workhorse" picks up 71% assembly savings...73% weight savings

Piasecki Helicopter Corporation uses Tubular SPEED CLIPS® to make spectacular savings over previous method of attaching blanket insulation

The "flying workhorse" for the Air Force and the Army, Piasecki's new helicopter carries aboard a top-flight example of SPEED NUT savings.

Blanket insulation has to be attached inside the craft in over 700 locations. The old fastening method needed revising to save assembly time and, more important, to save weight. The perfect answer . . . Tubular SPEED CLIPS and standard rivets. *They could take the place of complicated previous methods, and provide an amazing 71% assembly saving, and a total weight savings of 73%!*

Now Tinnerman Tubular Clips, along with hundreds of other SPEED NUTS, are specified for use on all Navy HUP-1 craft and also are used on the new Piasecki H-21 Air Force Assault and Army Transport Helicopter.

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OLD METHOD
CLIP
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NUT
WASHER
INSULATION BLANKET
GLOVE FASTENER STUD
GROMMET BUTTON
SPEED CLIP METHOD
TINNERMAN TUBULAR CLIP C 2733
INSULATION BLANKET
CLEARANCE HOLE
STANDARD RIVET
Drawings at left show obvious SPEED CLIP savings. Old method required complicated clip assembly to be riveted to panel. SPEED-CLIP needs only clearance hole in existing panel and rivet to provide vibration-proof attachment.
TINNERMAN Speed Nuts
FASTEST THING IN FASTENINGS

A Job for Engineering Societies

GRAFT, corruption and other forms of dishonesty are rampant in our national government, particularly in the highest levels. Because crookedness is condoned, it is encouraged. Who is the greater scoundrel —the racketeer who rose from the slums or the man born of means who, elected or appointed to high office, indulges in graft and corruption or condones it among his friends and fellow workers?

Already the effects of wide flung political corruption are beginning to be felt. The administration wails that it is not being trusted. The government has lost the respect of the people. The stampede of crookedness is trampling out the spirit of patriotism. Laymen stand aghast, hoping they are wrong but knowing it is the brutal truth. Confusion compounds confusion.

What can the engineer contribute to bring order and integrity out of the morass of weakness and immorality? It is his concern not only as a citizen but also because he has more to lose than many other groups. Much of the political corruption is related to the products and industries that have been or are being created by engineers.

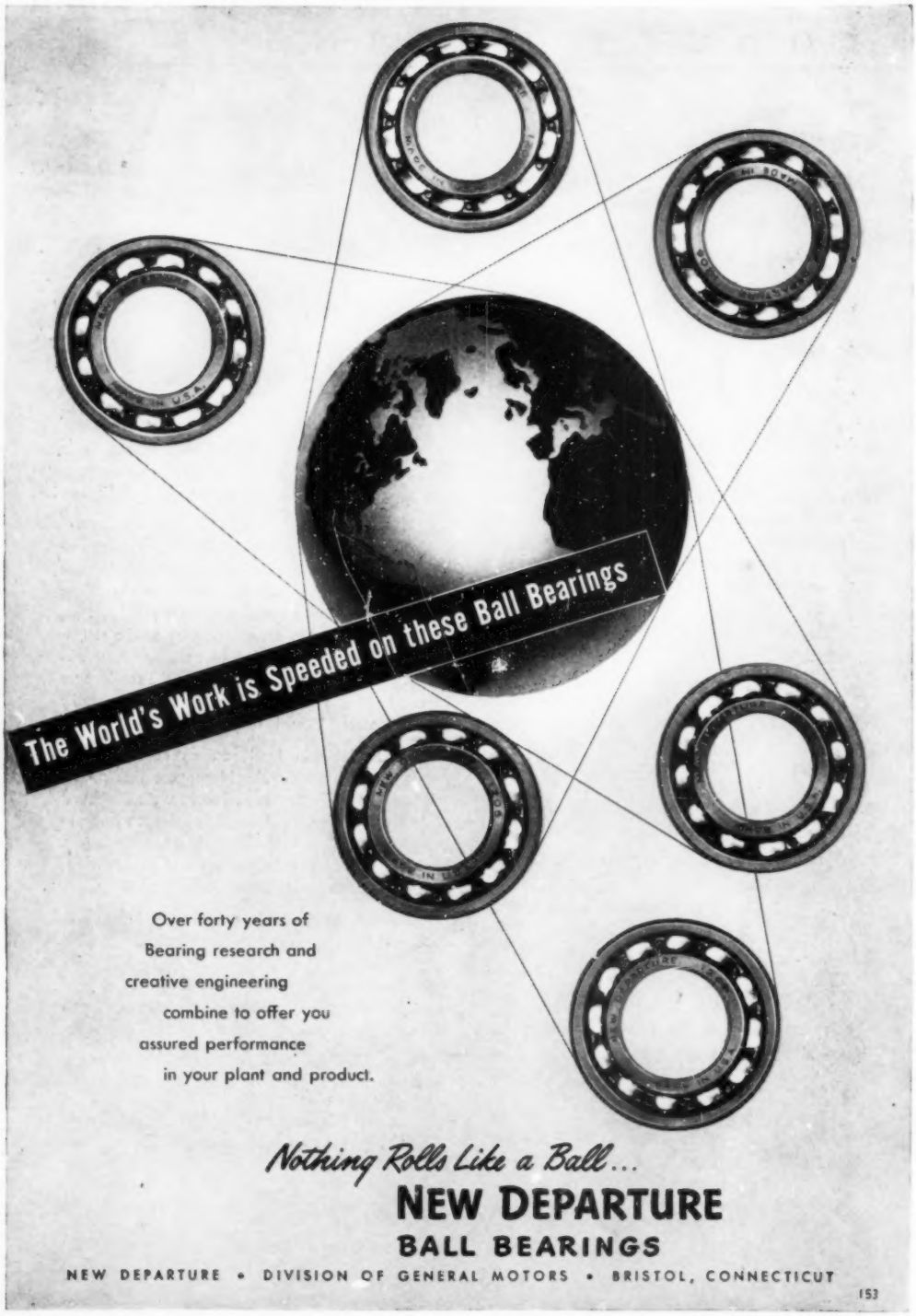
Engineers are also much concerned with the operation of many government bureaus—The Patent Office, Bureau of Standards, Federal Communications Commission, the Bureau of Explosion, the military and naval departments and many others. These represent added reasons why engineers should make their voices heard in an organized manner to stamp out the wave of stupidity, impropriety and dishonesty that has engulfed Washington.

With a total membership of almost one quarter of a million, the national engineering societies can bring to bear tremendous pressure upon the ruling politicians. It is not a question of party politics. Men of both major parties are contributing to the rottenness. It is solely a question of honesty versus dishonesty, chicanery versus integrity, or the condonance of crookedness versus a militant fight for morality in government.

As individuals in local sections or at national meetings the engineers should propose that proper actions be taken in the name of society. At the behest of its memberships the national societies can bring to bear upon legislators and administrators the power of their prestige and influence, to the end that corruption in government shall be minimized.

Let the crusade begin now so that the committees of the political parties will be impressed with the fact that candidates of questionable integrity will have little chance in the next national election. A good political house cleaning now might also attract men of proper stature and integrity as candidates for important elective offices.

G. F. Rodenbolt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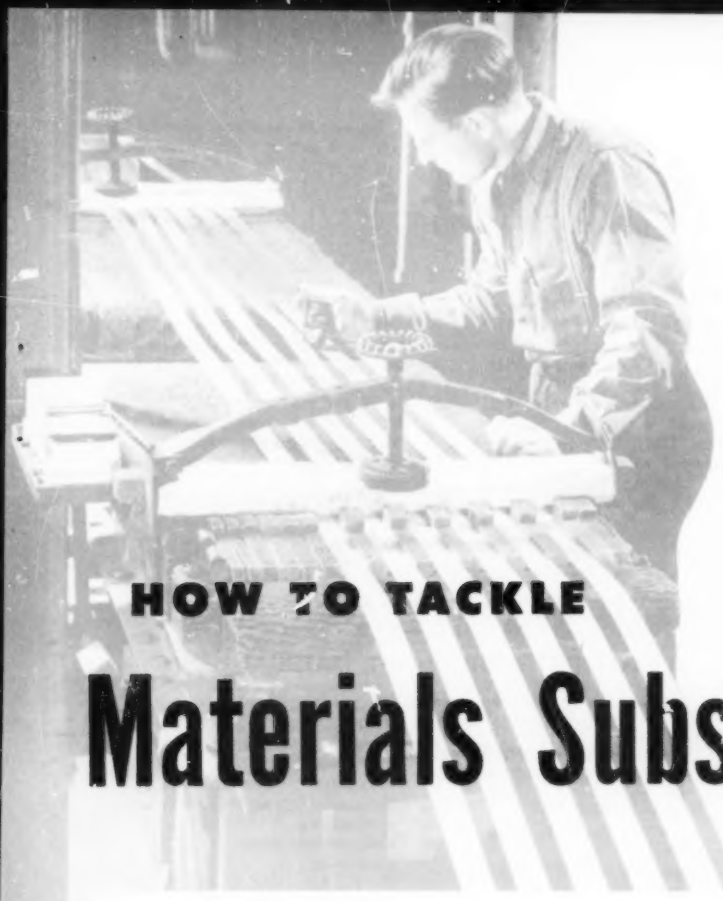


- The short and long range outlook in metals and non-metals.
- Fifteen suggestions that will help in assuring adequate supplies.
- Case examples of what some of the bigger companies are doing.
- Factors to consider when substituting one material for another.
- Where plastics fit into the picture and how they can be used.
- Specific data on substitutes for steel and other critical metals.
- New developments in metals and how industry plans to use them.

HOW TO TACKLE

Materials Substitution

THE pinch in many materials is just beginning to hurt. Up to now supplies have been spotty, but companies working on direct and supporting military programs have not had too much difficulty in balancing inventories with production schedules. Even manufacturers of consumer goods have been successful in maintaining production, although with some disruptions and cutbacks.

But for the next year, at least, the picture will get worse. The military program is just entering the production stages and is bound to create shortages in consumer manufacturing industries. Already the demand on the melt schedule of nickel-moly-cobalt steels is 2½ times the supply; in the case of chromium bearing steels, it is 1¾ over the production schedules. The plain fact is that something has to give. Some manufacturers will find their sources of supply cut-off. Others, including those working on direct military contacts, will have to use downgraded materials; already Army Ordnance, the Air Force, and Naval Bureau of Air, among others, have approved tentative substitutes for alloy steels. This is necessary, for the materials requirements for certain military hardware, and particularly for jet engines and electronic gear, are much more severe than during the last war; for example, the specifications on low temperature impact properties on armor plate for the tank program requires the use of steels with a nickel content of four to five hundred percent greater than during the last war.

If expansion programs charted by the Defense Minerals Administration keep on schedule, the day of full platter will return for many raw materials by the end of 1953. Expansion rests now on production projects approved for quick tax amortization and on minerals exploration projects receiving government assistance.

The really bad news list in 1953 will be a short one, but will include copper, tungsten, and cobalt.

There will also be a whopping deficit in titanium if DMA has it figured right; only about 15 percent of the demand will be met. But the very presence of this new metal on a list of structural materials is a hopeful sign. It can be substituted for nickel in many military uses, for example. DMA uses the current price of five dollars per lb for sponge metal as the basis for estimating 1953 demand. If the new process developed for the Navy actually reduces the cost to anywhere near the dollar per lb announced, use will skyrocket. There is plenty of ore for titanium in this country and Canada, so any shortage need be only temporary while processing plants are built.

DMA expects iron ore supplies to be six percent less than demand by the end of 1953, even figuring on 10-million tons of imports, and some production from taconite. But the steel industry has a way of coming up with ore for its furnaces as needed. The iron ore picture, as it shapes up on charts, will probably not cause any cut-backs in steel.

Lead will be in balance with demand by the target date, lacking only a fraction of one percent. Expansion already approved will provide 35,000 tons per year.

Aluminum production will equal demand well within the next two years, DMA believes. Magnesium is expected to meet foreseeable needs, and additional expansion can be provided if the aluminum program lags.

Imports of chromium, now the subject of debate in mobilization circles, can be stepped up to fill the foreseeable demand by the end of 1953.

Tin is in a class of its own. The government-sole buyer in the U. S. could get all it wants, at a price. As of this writing it has been temporarily out of the market in order to drive the price down. Up to June, the government-owned smelter in Texas was producing enough for current use and probably a little for the stockpile. But our biggest source of raw material for the smelter has been Bolivia, and our contract ran out there May 31. When a new Bolivian agreement is reached, the government can continue its fight against world prices indefinitely. If not, we will simply

CONSIDERATIONS IN SELECTING A SUBSTITUTE MATERIAL

PROPERTIES

- Melting point
- Transformation point
- Recrystallization point
- Specific gravity
- Electrical conductivity
- Electrical resistivity
- Thermal conductivity
- Thermal resistivity
- Coefficient of thermal expansion
- Ultimate strength, tension
- Ultimate strength, compression
- Yield strength, tension
- Yield strength, compression
- Proportional limit
- Modulus of elasticity
- Elongation in 2.0 in.
- Cup ductility
- Torsion properties
  Modulus of rigidity, Yield strength, Proportional limit, Strain at rupture.
- Ratio of tensile strength to density
- Ratio of compressive strength to density
- Ratio of torsional strength to density
- Hardness
  At sub-zero temperatures, At room temperatures, At elevated temperatures.
- Damping characteristics
- Impact strength
- Creep rate
  At room temperature, At elevated temperatures.
- Stress rupture time
- Notch sensitivity
- Endurance limit
- Other
  Reflection, Corrosion and oxidization resistance, Abrasion resistance, Permeability or dielectric constant, Arc resistance.

ASSEMBLY

- Arc Welding
  Manual d-c, Manual a-c, Automatic d-c, Automatic a-c, Submerged arc, Shielded arc.
- Resistance Welding
  Spot, Projection, Butt, Seam, Flash.
- Brazing
  Resistance brazing, Torch brazing, Induction brazing, Furnace brazing.
- Gas Welding
  Manual, Automatic.
- Soldering
- Riveting
- Others
  Self-tapping screws, Retaining rings, Standard bolts, Metal stitching, Threaded joints, Cementing, Shrink and press fits, Staking, Crimping.

COST

HEAT TREATMENT

- Hardening
- Annealing
- Low Temperature Treatment
- Surface hardening
  Cyaniding
  Flame
  Induction
  Nitriding
  Carburizing

FABRICATION

- Casting
  Die casting, Investment casting, Plaster mold casting, Sand casting, Permanent mold casting, Centrifugal casting.
- Molding
- Forming
  Bending, Stamping, Spinning, Die forming and drawing, Electroforming, Roll forming, Press brake forming, Pressing, hot or cold, Stretch or compression forming, Fluting, Embossing, Engraving.
- Forging
  Hammer, Upset, Drop die, Header.
- Metallizing
- Powder metallurgy
- Extrusion
  Die, hot or cold, Impact.
- Machining
  Turning, Milling, Drilling, Grinding, Reaming, Honing, Tapping, Contour Milling, Planing, Broaching, Chasing
- Other
  Roll threading, Cold heading, Flame cutting, Friction Sawing, Swaging.

FINISHING

- Plating
  Cadmium, Zinc, Copper, Chromium, Nickel, Silver, other.
- Polishing
- Buffing
- Scratch brushing
- Burnishing
- Barrel tumbling
- Sand or grit blasting
- Chemical Coatings
  Phosphates, Oxides.
- Shot peening
- Organic Coatings
  Natural Resins, Synthetic-thermoplastic and thermosetting (incl. Silicones).
- Painting
  Varnishes, Enamels, Lacquers, Wrinkle Finish.
- Staining
- Etching
- Coloring
- Electropolishing

have to pay somebody else's price or make temporary contracts.

Copper and tungsten head up the bad news list despite production increases. DMA has approved projects to turn out 139,000 additional tons of copper. But the best it foresees by the end of 1953 is a five percent rise in domestic output. Combined with imports, it expects supplies still will be 15 percent under demand.

DMA reported an 89 percent increase in domestic production of tungsten in May of this year, but production was low a year ago and an increase of that size is a small part of our needs, most of which are met by imports. There is nothing on the production side either in this country or abroad which DMA thinks can close the gap created by mobilization.

Cobalt is in the same class: far short of world needs. It will remain so far behind demand that designing it out of products—as the TV industry is doing—looks like the only relief.

Production of nickel and molybdenum, before 1953 is over, is expected to reach the 1951 level of demand. DMA has approved projects which would increase molybdenum 8-million lbs per year. International Nickel has already upped production 1-million lbs per month, and further nickel expansion is in the works. As new sources of production come in, these two metals will be used increasingly as substitutes for scarcer ones. They may not show up in easy supply even by the end of 1953, but they will be plentiful by present standards.

Manganese has been plentiful due to sustained imports and no shortage is expected. In addition, DMA has high hopes for increasing supplies from slag. Approved zinc projects will increase output 90,000 tons a year. By 1953, supply will equal 1951 demand.

The consumption side of these long-range estimates depends primarily on what the military does. A gradual paring back of military output would relieve many of the shortest materials well ahead of the DMA schedule. If Congress should approve an air force jump from 95 to 150 groups, as now proposed, it would put an additional strain on the same materials.

HOW TO SET UP A MATERIAL PROGRAM

For any one material there probably are at least twenty others that might be substituted for it. Whether any of these twenty substitutes can be used depends on the characteristics required in the product, the heat-treating and fabricating equipment that is available in the shop, and on numerous other factors.

Given the time, any engineer or metallurgist can analyze these requirements and come up with a satisfactory alternate, but in the meantime, the alternate may have become short. The only successful method for making substitutions is to establish a program and analyze requirements on a continuing basis. The following suggestions are in broad and somewhat general terms, but they will help in establishing such a program:

1. *Keep-abreast of the substitute recommendations of societies and suppliers.* Much of the original work that has been done by the Defense Minerals Administration and various branches of the armed forces has been a cooperative endeavor with technical societies and committees. The new TS (tentative standard) steels which for the most part are downgraded NE (national emergency) steels are the subject of several bulletins of the American Iron and Steel Institute and the Society of Automotive Engineers. The Society of the Plastic Industries has accumulated considerable data on plastics availability and substitutes. For the most part, committees established by these and other societies are moving with speed and foresight.

Another excellent source of information is the suppliers' representatives. Materials salesmen are in daily contact with their regional or house offices and as a result are posted on government regulations and the supply situation. In addition, they usually are up to date on successful substitutes that are being made by companies in the same product line. Keeping a loose leaf reference book of standards issued by societies, publications issued by materials suppliers, and articles appearing in technical and trade magazines will prove of definite value.

2. *Set-up a method for approving temporary changes.* The procedure for approval of engineering changes is, in most plants, quite involved. Unless the substitution of one material for another is expected to last for an extended period, there is no need to change drawings, issue formal change over notices, or request management or sales department approval before the change is made.

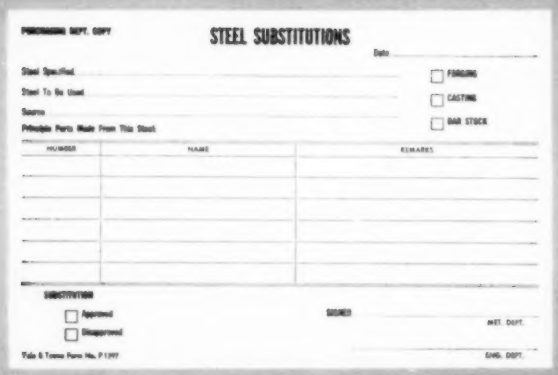
One typical form used to authorize steel substitutions is shown in the following page illustration. The request for this change usually is initiated by the purchasing department, which may be having difficulty in obtaining adequate supply of a particular type and form of material. After an informal discussion with the designer or product engineer to determine if the substitute will meet physical requirements, the form is routed to authorized personnel in the engineering and metallurgical department for approval. If approved, the production department is notified and the change is made.

Also, change in the form of a material may be as important as switching to an entirely different type. For example, extruded aluminum forms may be scarce, but sheet stock might be available. If so, and in sufficient quantity to justify tooling for press brake or cold roll forming, a change should be authorized. In any case, the procedure for authorizing such substitutions should be simple and flexible, particularly if the change is a temporary one.

3. *Specify standard materials and components.* Special materials specification might be justified in ordinary times, but special compositions, special quality or treatment, non-standard tolerances, or out of size dimensions on mill products are now almost impossible to obtain and certainly make it more difficult to insure adequate supplies. This should be one of the initial points of attack in establishing a substitution program.

The same thing applies to operating components and other items. The materials handling division of Yale and Towne, for example, specified rubber coated wire all during the last war. It was a continuous headache to obtain any kind of a working inventory. They have long since gone to enameled wire for many applications.

Electrical motors are another example, for as during the last war, they are extremely tight. D-c motors, since they contain more copper, are in worse



PURCHASING DEPT. COPY

STEEL SUBSTITUTIONS

Date

Steel Specified

Steel To Be Used

Source

Principle Parts Made From This Steel

☐ FORGING

☐ CASTING

☐ BAR STOCK

NUMBER	NAME	REMARKS

SUBSTITUTION

☐ Approved

☐ Disapproved

SIGNED

MET. DEPT.

ENG. DEPT.

Yale & Towne Form No. P 1197

Type of form that can be used to approve temporary substitution of materials. In a small or medium sized company, it may also prove satisfactory for permanent substitutes although more data usually are required.

supply than a-c types. Special requirements mean that the supplier must disrupt production or at least make minor modifications in his production lines to accomodate a special order. This he is unlikely to do, especially when his backlog is at least a year on standard type.

Concentrating on engineering standards pays off in terms of availability right now, and in the long run results in lower costs. Many companies are using display panels in the engineering department to highlight critical items. Standard fastening devices, springs, hydraulic fittings, valves, and other components in approved types and sizes are mounted on display boards so that visual inspection can be made prior to specification. Douglas Aircraft even utilizes drafting stencils for such items as hydraulic fittings, and has found that they decrease drafting time as much as 20 percent.

In still another instance, one concern is using photographs as well as sketches in their standards manual so that complete visualization is possible.

4. *Downgrade requirements on alloys, particularly on steels.* Approximately 50,000 requests per month for CMP certificates come into the iron and steel division of DMA. Each request is considered on an individual basis. But since steel mills cannot get enough nickel or molybdenum to meet their melt schedules, downgrading is mandatory.

If the user has a good story, DMA officials will listen to him. In the case of materials for certain electrical applications or for thermostatic bimetal, it is difficult to make substitutions and the user's request probably would be approved. In the case of materials for structural applications, DMA is being hard-boiled. Unless the user can prove that a high alloy steel is necessary, he may have to use one of the TS (tentative standard) or boron steel alloys. Cuts will be made on a percentage basis, with direct military users getting the highest percentage, supporting military the next highest, and civilian users, what is left.

In many companies, the engineering department has broken down the materials requirements into two groups. One group consists of materials for driveshafts, gears, or heavily loaded structural elements, which must be considered on an individual basis. The second group consists of materials for secondary structures, for which the substitute possibilities are much broader. An aluminum die cast housing, for example, might easily be replaced with a malleable iron casting. Approving a broad substitution program on non-critical items will allow the purchasing department more freedom of action and permit more time to be devoted to materials for critical components and structures. In the table II is shown a list of substitutes developed without consideration for specific application by Yale & Towne.

5. *Investigate all facets of a proposed substitution.* The designer occasionally is inclined to consider mechanical properties above all others in analyzing a material as a substitute. There is much more to be considered, (Table page 124) including:

PHYSICAL AS WELL AS MECHANICAL PROPERTIES. Mechanical properties such as tensile and yield strength, modulus of elasticity and cup ductility may be important, but physical properties such as melting point, coefficient of thermal expansion, or permeability can also effect success or failure of an application.

HEAT TREATING CHARACTERISTICS. The application of many substitute steels, for example, depends on hardening characteristics or adaptability to annealing, sub-zero treatment or surface hardening treatments.

ADAPTABILITY TO PROPOSED FABRICATION METHODS. Whether the material can be cast, forged, produced by powder metallurgy techniques or fabricated by other methods available to the shop is equally important as mechanical properties.

METHOD OF ASSEMBLY. When a material that has been welded, soldered, riveted, brazed, or assembled by self-tapping screws becomes short and another material must be substituted, it should be suitable for assembly by the same techniques or techniques equally satisfactory.

METHOD OF FINISHING. Not only the type but also the form of the material may govern the finishing method, particularly when chemical dips or electrochemical procedures are used.

COST OF MATERIAL AND EQUIPMENT. Raw material costs represent only a small portion of the cost of the finished product; the cost of performing any of the previous operations can overshadow this. Insofar as materials costs are concerned, two facts are important: (1) the cost of substitute materials such as TS or boron steels are priced below the standard alloy steels; this was not true during the last war. (2) The price quoted on a material at the mill and the delivery price from a warehouse are two entirely different things. The grey market is back in many materials.

6. *Consider redesign to reduce requirements.* If a product is properly designed and the material for it has been properly selected, any substitute will be less satisfactory in some respect —cost, strength, life, machineability, or other property.

The fact of the matter is, however, that many products are over designed and the material for them has been selected on an "opinion" basis. When materials for television receivers began to get short, for example, DuMont investigated and found that the gage of sheet used for the chassis could be cut in half without any effect whatsoever on receiver performance or quality. To play safe, the average designer selects a better material than he needs and then adds a factor of safety of three or four, which may not be justified.

SUBSTITUTE ALLOY, CARBON, AND FREE-MACHINING STEELS

SELECTED STEEL	RECOMMENDED SUBSTITUTES 1st CHOICE	2nd CHOICE	3rd CHOICE	4th CHOICE	REMARKS
ALLOY STEELS					
SAE 2317-AISI 2315	SAE 3115, or AISI 3120	SAE 8615, SAE 8617, or AISI 8620	SAE 8719, or AISI 8720	SAE 4615, SAE 4617, or AISI 4620	As a fifth choice, SAE 8822 can be specified.
SAE-AISI 2512	SAE 2515, or AISI 2517	SAE 4815, SAE 4817, or AISI 4820	SAE 8615, SAE 8617, or AISI 8620	SAE 8820	
SAE-AISI 3140	SAE 3135, or AISI 3141	SAE 4137, SAE 4140, or AISI 4142	SAE 8637-40 AISI 8641-42	SAE 8740, or AISI 8742	Other possible substitutes are SAE 4140, or SAE 5140.
SAE 4140 (Nitrided)	SAE 4137, SAE 4140, or AISI 4142	Nitralloy			Only substitutes when steel is to be nitrided.
SAE 4140	SAE 4137, or AISI 4142	SAE 3135, SAE 3140, or AISI 3141	SAE 9840, or AISI 9845	SAE 8637-40, or AISI 8641-42	Other substitutes are SAE 8740, AISI 8742, or SAE 5140.
SAE-AISI 4340	SAE 4337	SAE 9840, or AISI 9845	SAE 4137, SAE 4140, or AISI 4142	SAE 3140, or AISI 3141	SAE 1045 can be used when equipment is available for heat-treatment, induction hardening, and spray-quenching.
SAE-AISI 4615	SAE 4617, or AISI 4620	SAE 8615, SAE 8617, or AISI 8620	SAE 8719, or AISI 8720	SAE 3115, or AISI 3120	As a fifth choice, SAE 8822 can be used.
SAE-AISI 4815	SAE 4812, SAE 4817, or AISI 2517	SAE 2512, SAE 2515, or AISI 2517	SAE 4317, or AISI 4320	SAE 8615, SAE 8617, or AISI 8620	As a fifth choice, SAE 8719, or AISI 8720 can be used. Also, SAE 8822 can be used.
SAE-AISI 8615	SAE 8719, or AISI 8720	SAE 8615, SAE 4617, or AISI 4620	SAE 8822		
FREE-MACHINING STEELS					
SAE 1112-AISI B1112	SAE 1113, or AISI B1113	SAE 1111, or AISI B1111	AISI C1110	SAE 1115, or AISI C115	Other substitutes are SAE 1117, AISI C1117, SAE 1118 and AISI C1118. With the exception of 1117 and 1118, these steels should not be heat-treated or welded.
SAE 1117-AISI C1117	SAE 1118 AISI C1118				
SAE 1137-AISI C1137	SAE 1141, or AISI C1141	SAE 1132, or AISI C1132			
CARBON STEELS					
SAE 1020-AISI C1017	SAE 1015-17 AISI C1015-17	SAE X1314 AISI C1117	SAE X1315, or AISI C1118	SAE X1020-AISI C1022 SAE 1018-AISI C1018 SAE 1019-AISI C1019 SAE 1021-AISI C1021	Fourth group of substitutes has poorer machining characteristics. All substitutes have equally good carburizing characteristics. When no heat-treating or welding is required, SAE 1115, or 1120, or AISI C1115, or C1120 can be used.
SAE-AISI 1035	AISI C1037	SAE 1038, or AISI C1038	SAE 1040, or AISI C1040	SAE 1033-AISI C1033	Other substitutes: SAE 1137, or AISI C1137; SAE 1141, or AISI C1141; SAE-AISI 8630 alloy; SAE-AISI 8632 alloy.
SAE-AISI 1040	AISI C1037	SAE 1038, or AISI C1038	SAE 1039, or AISI C1039	SAE 1042, or AISI C1042	Other substitutes: SAE 1137, or AISI C1137; SAE 1141, or AISI C1141; SAE-AISI 8635 alloy; SAE-AISI 8637 alloy.
SAE-AISI 1045	SAE 1043, or AISI C1043	SAE 1042, or AISI C1042	SAE 1046, or AISI C1046	SAE 1049, or AISI C1049	Other substitutes: SAE 1050, or AISI C1050; SAE 1137, or AISI C1137; SAE 1141, or AISI C1141; SAE-AISI 8640.
SAE-AISI 1075	SAE 1078, or AISI C1078	SAE 1080, or AISI C1080	AISI 1072		
SAE-AISI 1095 Drill rod	SAE 1090, or AISI C1090	SAE 1086, or AISI C1086			

Few concerns have the money or time to actually estimate the number of stress reversals that a shaft must withstand and then actually test a model of the projected design to destruction. But a close examination or test of a structure will often result in appreciable savings in materials. Sometimes, but not often, a part can be designed right out of the product.

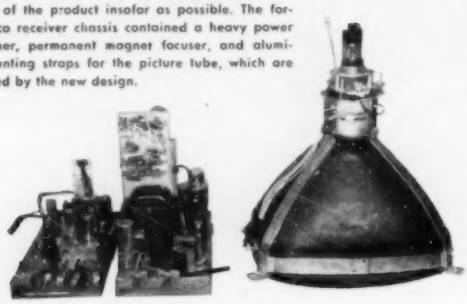
7. *Investigate pre-stressing of materials.* Pre-stressing of components and structures is an excellent approach to longer life, better performance, and in many instances, reduced alloy or size requirements. The importance that the editors of *Product Engineering* attribute to this subject is illustrated by the series of articles that have been run on the subject by J. O. Almen of the Research Laboratories Division, General Motors Corporation. See previous issues in 1950 and 1951.

An example of an approach being made along this line is the use of SAE 1045 or 1050 carbon steel to replace alloy steels such as 4340 or 9840. This is done by heat-treating, drawing back for core strength, and induction hardening and spray quenching to induce

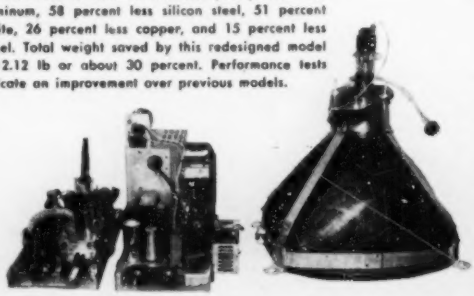
CASE STUDIES OF MATERIALS SUBSTITUTIONS

These aluminum nameplates used on Delco Appliance Rigidframe motors are now made of stock which is only 0.016 in. in thickness as contrasted with the old stock which was 0.0225 in. It can easily be seen in the picture that there is an appreciable difference in even as small a quantity as one hundred nameplates. Other substitutes developed by Delco engineers include: (1) Steel tubing has been substituted for aluminum rod for our automobile heater motor commutator bushings. This bushing takes the strain in pressing molded phenolic commutators on the shafts and also acts as a spacer. (2) Nickel plated steel brush holders have replaced the former holders made of brass strip on automobile heater motors. Internal fractional horsepower motor leads formerly employed rubber. Now plastic insulation has been substituted with satisfactory performance. (3) Copper is conserved and performance unaffected by replacing copper tubing on burner fuel lines with steel tubing. The humidifier pans used on certain pieces of equipment have been changed from stainless steel to vitrified enamel on carbon steel. Here is another example of a materials change which has little or no effect on performance. (4) Shallow well pump crossheads were formerly made from die cast zinc. Cast iron has replaced the zinc. This change too has no effect on performance or quality.

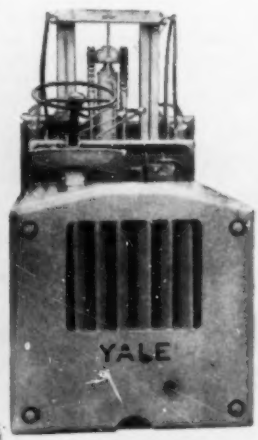
The television industry, and the Philco Corporation in particular, was one of the first to design critical materials out of the product insofar as possible. The former Philco receiver chassis contained a heavy power transformer, permanent magnet focuser, and aluminum mounting straps for the picture tube, which are eliminated by the new design.



The new receiver contains no cobalt, 68 percent less aluminum, 58 percent less silicon steel, 51 percent ferrite, 26 percent less copper, and 15 percent less nickel. Total weight saved by this redesigned model is 12.12 lb or about 30 percent. Performance tests indicate an improvement over previous models.

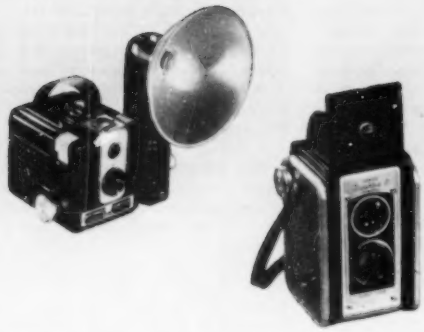


The one piece counter weight and radiator cover for the Yale and Towne line of fork lift trucks formerly was fabricated of cold rolled steel. After machining, which represented a problem in handling and cost, the housing was mounted on a jig and poured full of lead to increase the weight to approximately 1800 pounds.



Typical of the changes made by the Hoover Co. are those illustrated above: the fabricated motor commutator, left, has been replaced by a molded plastic commutator that is being obtained from Hoover, Limited of England, and which reduces the weight of copper required; the locating plate for the hood of one model vacuum cleaner is finished with a chemical treatment to provide corrosion resistance rather than cadmium plated.

In the new truck models, the counterweight is a gray iron casting. The weight is sufficient without adding lead. Bolt holes as well as radiator louvers are cast, so machining has been practically eliminated. In addition appearance has been improved, available materials are being used, and cost has been reduced 75 percent. Pattern costs were written off in three weeks.



On this Kodak Duplex II Camera the metal moldings on the sides of its front plate are to be replaced by leather, the front panel behind the nameplate will be climated and replaced by a larger nameplate, and the metal identifying button, top center, will be replaced by decal. On the Brownie Hawkeye, the bezel that runs up the front and around the viewfinder is being changed from aluminum to steel.

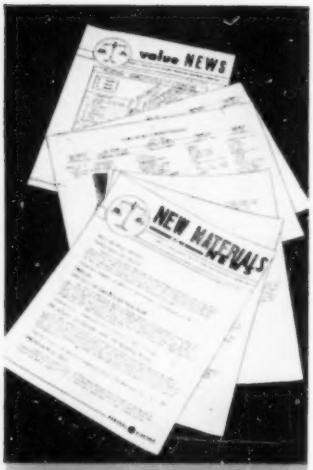
Molded fiber carrying case for projectors and cameras manufactured by Revere Camera Company are light in weight, highly resistant to impact, and resist oils, moisture, and abrasion. The material is an accreted or wet formed structure made from cellulose fibers, a melamine resin, and Hycar latex.

Bearing pins for this Allis Chalmers 800 amp d-c contactor formerly were made of Monel because of its corrosion resistance and non-magnetic properties. But since non-magnetic pins are not required in contactors or switches, Type 410 or 416 stainless steel has been substituted. This small change, multiplied by the 50,000 pins required per year, saves several hundred pounds of nickel.

Contact jaw for automatic welding head made of Lincalloy, which was developed by Lincoln Electric to replace a precipitation hardening copper alloy. Hidden arc welding equipment is used to make, under an arc completely covered by granular flux, a mechanical solution of copper and steel. Scrap copper, turning chips from commutator turning operations, are placed on a steel strip. Using a mild steel welding wire, an arc is established and moved along the strip, digging into the steel strip, melting the copper, and mixing it with the molten steel in the weld crater. The mixture varies throughout the solution, but a cross section will show an average mixture of 50 percent steel and 50 percent copper.

Lincalloy is harder than steel, and therefore gives excellent wearing qualities in the contact areas of ground clamps, holders, and jaws. In addition to having low contact drop, the tendency for Lincalloy to weld to steel at high current densities is less than that of other materials used for this same purpose. A comparative test showed following hardnesses:

Soft Copper	37F
Hard Drawn Copper	43-45B Rockwell
Precipitation Hardening Alloy	47-62B Rockwell
Mild Steel	64-68B Rockwell
Lincalloy	80-115B Rockwell



Publications issued by the purchasing department of General Electric to keep designers abreast of substitutes.

compressive stress and increase tensile strength. Both Caterpillar Tractor and Chrysler are using this technique.

8. *Check scrap losses against different methods of fabrication.* Often using the same material but another method of production results in substantially lower scrap losses and more output per pound of incoming stock. Powdered metal gears in place of cut or ground gears, die cast rather than machined housings, or precision cast rather than machined parts are typical of such changes. Often the analysis of fabrication methods indicates a change that can be made to secure better material supply, as for example, powdered graphite bushings for bronze bushings.

At the Philadelphia Division of Yale and Towne, a number of items have been switched from machining stock to forgings because of better availability. In other instances cast steel has been substituted for forgings, and ductile cast iron (see page 133) for cold rolled steel; the use of ductile cast iron is especially practicable for hydraulic equipment. Meehanite and Gunite castings also have been used in many instances. To insure proper heat treatment and processing, all alloy steel forgings and castings are marked with the alloy number. If the part is a casting the number is cut on the pattern; if it is a forging, knock-out numbers are used in the forging die.

9. *Propose other methods for increasing materials inventories.* There are many methods of improving inventories on materials that are not directly in the province of the engineering department. Nevertheless, the engineer is indirectly involved in these methods at least to the extent that they make his job easier or prevent temporary shutdowns.

OBTAINING MILITARY CONTRACTS or sub-contracts is the function of management or the sales department, but the engineering department often can provide guidance on the type of product to investigate and the proper individuals to contact. The greater the number of direct or supporting military contacts, the better the opportunities for securing adequate materials supplies.

DEVELOPING FOREIGN SOURCES OF SUPPLY is an excellent hedge against shortages. Import agents, subscriptions to selected foreign periodicals, and contacts through foreign sales agents and licenses are methods being successfully used. Also, sales of equipment to foreign concerns sometimes can be followed through to obtain return shipments of mill products or raw materials.

HELPING PARTS SUPPLIERS SECURE MATERIALS insures adequate delivery on components. Periodic visits to suppliers by a member of the engineering department should be made to determine requirements and problems.

PROJECTING MODEL CHANGES AND PRODUCTION SCHEDULES well ahead, and letting the supplier in on the anticipated requirements is a current necessity. One concern for example, operates on a five month lead time on hydraulic cylinders, but are informing their suppliers of production requirements a year ahead of time.

OPERATING ON A COMMITTEE BASIS with engineering, purchasing, and metallurgical participating is a sound procedure for both large and small plants. In a small concern, representatives of these departments can get together on an informal basis; in a large plant, the set-up is usually more elaborate.

WHAT THE LARGER COMPANIES ARE DOING

The present arrangement at Allis-Chalmers for the clearance and approval of substitute materials provides for a review of each material problem as it is related to a specific part, and each of these must be passed on by the Committee on Emergency Substitutions of Materials and Products. This committee has engineers of the highest standing in the company as members, these being drawn from the engineering standardization section.

To meet the situations presently arising, the committee is providing alternate materials in two categories; namely the temporary or emergency alternate group and the permanent interchangeable group. Emergency specifications are returned to the original materials as soon as possible. The other category, includes groups of materials considered equally acceptable for specific products. When materials are placed in this latter group, they are authorized for dispersement and use without requiring changes of materials designated on existing drawings.

Examples of the Emergency Alternate Group:

Zinc electroplated fastening devices, given a suitable sealing treatment (such as a dichromatic dip), are substituted for cadmium plated devices. The dip treatment prevents the formation of white corrosion salts and extends the life of the pieces. Cadmium plated fasteners are superior to these, and the return to cadmium will be made as soon as materials are available.

Cold-finished stress relieved steel is used as an emergnecy substitute for hot-rolled steel with the same chemical analysis when the latter cannot be procured. A return to the hot-rolled steel is made as soon as possible due to the extra expense of the emergency substitute. This material is primarily in the form of bars.

Cast copper alloys are being revised to minimize the demand for tin. In different applications, the tin content has been reduced to six, ten or twelve percent, depending on the content declared necessary by the committee.

Cadmium content of silver solders has been reduced from 24 percent to a 19 percent maximum. The silver content has been raised to compensate for this drop.

Examples of the Permanent Interchangeable Group:

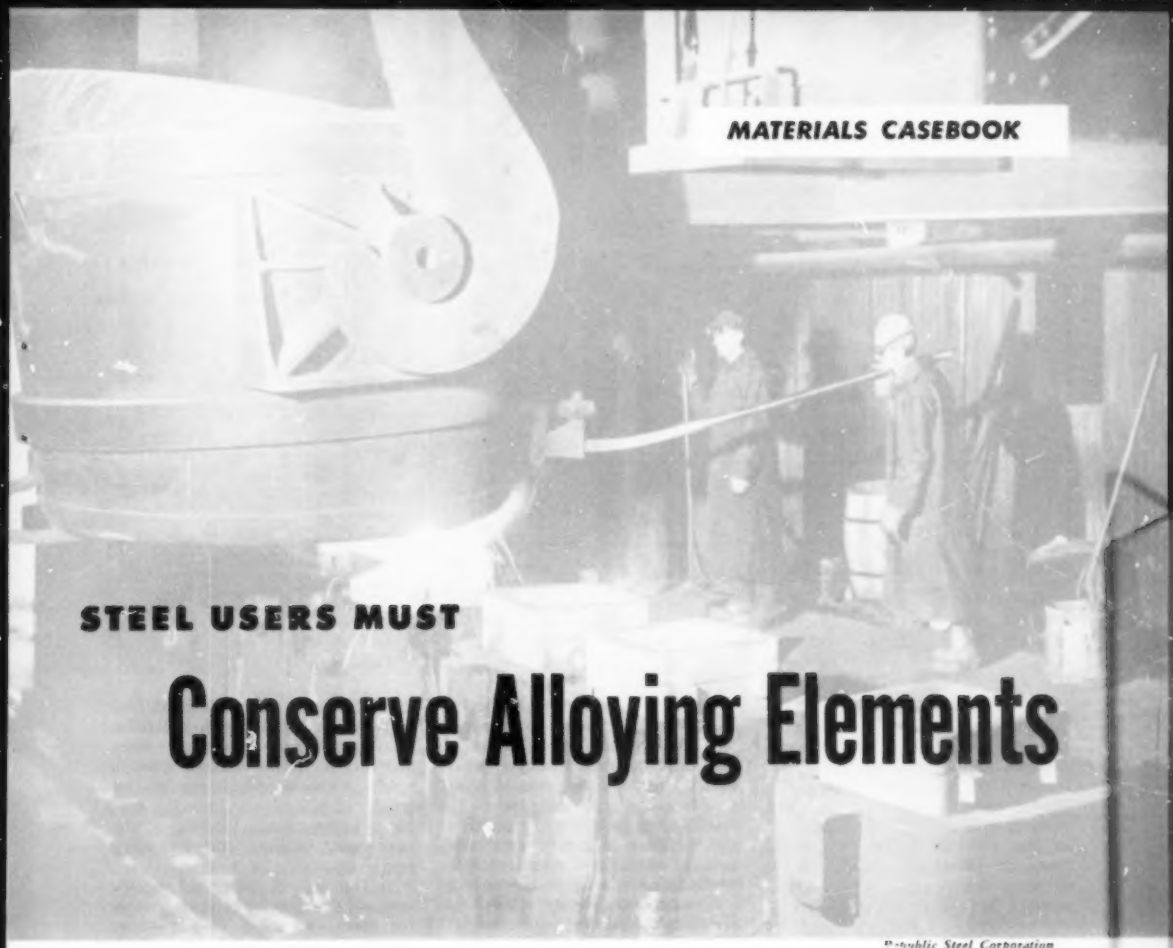
Carbon steels and alloys steels, with expanded groups of interchangeable steels. Within these groups, the physical properties of the original metal may be had by proper heat treatment of the substitute.

An example of this is found in the bolts used in a high-temperature pressure vessel. This originally required SAE 3140 steel, but now is fabricated from the following steels and is heat-treated to obtain the required physical properties:

AISE or SAE	4140	8640	8740
	4142	8642	8742
	4145	8645	8745
	9445	9442	9440

In other words, a total of fifteen alternate materials can be drawn on for the steel for this particular part, but this is not a blanket authorization to use these materials as a substitute for 3140 in any other application.

Each application should be considered separately to obtain the best results.



Republic Steel Corporation

STEEL USERS MUST

Conserve Alloying Elements

STEEL production continues to break all records yet the critical shortage of alloying elements threatens to upset the industry. Tungsten, nickel, cobalt, chromium, molybdenum and columbium are the elements needed for the high strength, high tempearture and corrosion resistant steels. We are dependent upon imports for a large percentage of most of these materials. Tungsten is especially critical since Red China and Korea formerly supplied us with three fourths of our needs.

The development of domestic sources of supply and the expansion of friendly foreign capacity will require several years. In the meanwhile industry is forced to concentrate on conservation of these alloying elements. Several courses of action are: The use of leaner alloy steels; the replacement of alloy steels with carbon steels through revised heat treatment practice; the use of materials other than steel which are in more abundant supply; new methods of fabrication which require less metal; and where hardenability is the major requirement —the use of the boron steels.

Boron Steels—Hardenability, or the depth to which the formation of the hard structure, martensite, can be obtained by practical quenching techniques, is a prime requisite for high strength and wear resistance. Normally, additions of nickel, chromium and molybdenum are necessary to provide good hardenability. A considerable reduction in the amount of these elements required is possible through the addition of small amounts of boron. A replacement of several hundred times its own weight of manganese, chromium, molybdenum or nickel is not unusual. The supply of boron, derived from borax, is unlimited.

The development of the boron steels is being pursued with even greater intensity than during the last war. Their successful application requires a thorough understanding of their properties, transformation characteristics, heat treatment, tempering behavior and processing procedures. This, of course, is true of any new alloy and is therefore not to be considered as a deterrent to the use of the boron steels.

Some definite advantages over the general alloy steels exist. These include improved hot and cold forming, shorter annealing cycles, easier descaling and better machinability. These improvements are primarily a result of the lower total alloy content.

Precautions must be taken in carburizing and annealing boron steels because of the adverse effect of increased carbon content on hardenability, and because boron has very little if any effect in retarding softening at elevated temperatures.

The use of boron steels did not stop

AISI BORON STEELS

Grade	CHEMICAL COMPOSITION LIMITS, PER CENT					
	C	Mn	Si	Ni	Cr	Mo
80B15	0.12/0.18	0.60/0.90	0.20/0.35	0.20/0.40	0.15/0.35	0.08/0.15
80B17	0.14/0.20	"	"	"	"	"
80B20	0.17/0.23	"	"	"	"	"
80B25	0.21/0.28	"	"	"	"	"
80B30	0.27/0.34	0.55/0.80	"	"	"	"
80B35	0.32/0.39	0.65/0.95	"	"	"	"
80B40	0.37/0.45	0.70/1.00	"	"	"	"
80B45	0.42/0.50	"	"	"	"	"
80B50	0.47/0.55	"	"	"	0.25/0.50	"
80B55	0.50/0.60	"	"	"	0.30/0.55	"
80B60	0.55/0.65	"	"	"	"	"
81B35	0.32/0.39	0.70/1.00	0.20/0.35	0.20/0.40	0.30/0.55	0.08/0.15
81B40	0.37/0.45	"	"	"	"	"
81B45	0.42/0.50	"	"	"	"	"
81B50	0.47/0.55	0.75/1.05	"	"	0.35/0.60	"
TS 94B17	0.15/0.20	0.75/1.00	0.20/0.35	0.30/0.60	0.30/0.50	0.08/0.15
TS 94B20	0.17/0.22	"	"	"	"	"
TS 86B45	0.43/0.48	0.75/1.00	0.20/0.35	0.40/0.70	0.55/0.75	0.08/0.15

TENTATIVE STANDARD AND BORON STEEL SUBSTITUTIONS

SAE Standard Steel	Type of Heat Treatment	Recommended Alternates
1300	Carburizing and through hardening	No change
2300	Carburizing	TS 8600
	Through hardening	TS 8600
2500	Carburizing	TS 8600
3100	Carburizing and through hardening	TS 8600
3300	Carburizing	43 B00
4000	Carburizing and through hardening	TS 8100
4068	Spring	AISI 5100
4100	Through hardening	TS 4100* 81 B00
4300	Carburizing	TS 94 B00
	Through hardening (under 3 in.)	TS 86 B00
	Through hardening (over 3 in.)	AISI 9800* TS 86 B00
4600	Carburizing	TS 94 B00
	Through hardening	TS 8600* 80 B00
4800	Carburizing	43 B00* TS 94 B00
5000	Through hardening	No change
5100	Carburizing	No change
	Through hardening	No change
50100	Through hardening	No change
51100	Through hardening	No change
52100	Through hardening	No change
6100	Carburizing	No change
	Through hardening	No change
8600	Carburizing and through hardening	TS 8600* 80 B00
8700	Carburizing and through hardening	TS 8600* 80 B00
9200	Through hardening	No change
9300	Carburizing	43 B00
9400	Through hardening	No change
9700	Through hardening	TS 8100
9800	Through hardening	TS 86 B00

* Transitional Alternate

completely with the termination of the last war. Several companies continued to specify such material and have been using it consistently for structural parts formerly requiring the more highly alloyed steels. Recent and anticipated developments in alloy composition and in heat treatment techniques should contribute effectively to the adoption of boron steels as standard structural alloys. Successful control of quality can be maintained through the use of the SAE end-quench hardenability test and by the use of the spectrograph for detecting the presence of the necessary residual boron.

Alloy downgrading or the use of a lesser amount of alloying elements is another course being followed to conserve the critical metals. A group of these modifications is included and discussed in the introductory section of this issue.

Heat Treated Carbon Steels—Even greater savings of critical alloying elements can be effected by the replacement of the alloy steel with a plain carbon steel. This is quite feasible for many applications through proper heat treatment. The art of heat treatment has in many respects degenerated as a result of the widespread use of alloy steels. The latter require less critical heating and quenching practices to obtain the desired hardness because of their slower transformation rates. This factor plus the sales appeal of the mysterious word "alloy" have contributed to the use of alloy steels in applications for which plain carbon steels have served successfully for years.

Good heat treating practice costs no more than poor heat treating practice. Modern temperature control equipment facilitates the heating cycle. The quenching procedure is the source of most violations of correct heat treating practice. A fuller knowledge of the principles of heat treatment and the application of recently developed quenching techniques could effectively curtail the use of critically short materials. Plain carbon steels can at least be used for parts of light to moderate section thickness. Automobile parts, such as crank shafts, piston connecting rods, cam shaft, drive shafts, and gears, are examples.

For applications requiring only surface hardness for wear resistance, recent developments in batch and continuous gas carburizing, carbo-nitriding, and hard chrome plating will further extend the use of plain carbon steels.

Redesign for Other Processes—The course of redesign for materials conservation is one which is pursued constantly from a cost reduction standpoint. During this present emergency, however, there is a need for a more intensive effort. Some suggested alternatives are as follows:

1. The use of welded wire and wire and sheet assembly in place of solid sheet items or castings. Trays, handles and racks are examples of parts which can be converted to this method.

2. The application of rigidized metal to obtain higher strength and impact resistance through metal redistribution. The lighter gage sheet necessary to obtain required strength results in considerable savings of material. Applications include floor plates, boiler casings, ladders, laundry equipment, cabinets laboratory equipment.

3. The use of powdered metals. Iron and steel powder parts are suitable for gears, cams, and other machine parts. The strength of these parts is sufficient for many applications. When properly designed, parts can be molded to finished size with resultant savings in machining.

Replacement Materials—The direct replacement of steel with other materials involves the problem of where to get these materials. Most of the other metals are also in short supply. Aluminum, however, is threatening to replace steel for many applications due to its light weight. Although also under complete allocation there exists the possibility of relaxation of controls on this material in the near future. Ease of fabrication and good corrosion resistance are other assets adding to its interest.

Of the non-metallic materials the glass reinforced polyesters show the most promise as steel replacements. Their high strength, light weight and formability make them adaptable to many applications for which steel is now used. Their physical properties and industrial applications are more fully covered in the plastics section.

REPRESENTATIVE MECHANICAL PROPERTIES OF COMMERCIAL HEATS OF DUCTILE IRON

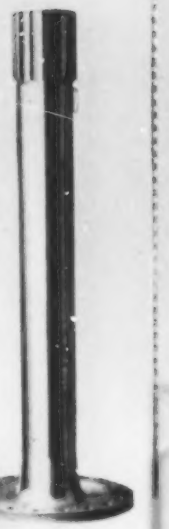
Grade	Tensile strength psi	Yield strength psi	Elongation per cent	BHN	Usual condition
A 90-65-02	95/105,000	70/75,000	2.5/5.5	225/265	As-cast
B 80-60-05	85/95,000	65/70,000	5.5/10.0	195/225	As-cast
C 60-45-15	65/75,000	50/60,000	17.0/23.0	140/180	Annealed
D 80-60-00	85/95,000	65/75,000	1.0/3.0	230/290	As-cast

A Pearlitic in structure. Provides good mechanical wear resistance.

B Pearlitic-ferritic in structure. Provides strength and toughness combined.

C A fully ferritic structure usually obtained by short anneal of either (A) or (B). Provides optimum machinability and maximum toughness.

D Higher phosphorus content than preceding grades, also higher manganese. Provides high strength and stiffness, but only moderate impact strength.



Parts fabricated from boron steel. Replacement of 3½ percent nickel steel (SAE ☆ 2345) and 2 percent nickel-chromium-molybdenum steel (SAE ☆ 4340) in heavy duty axle shafts, and was effected by the use of a lean alloy boron steel. These shafts were used in motorgraders and wheel tractors. No field failures of these parts have been experienced that can be attributed to the use of boron as an alloying agent.

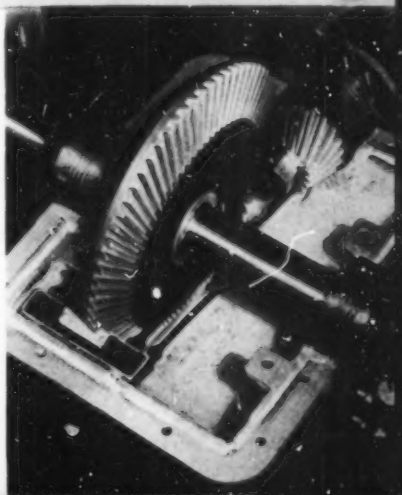
Caterpillar Tractor Co.

Ductile iron cylinder bushing for a plastic extrusion press. These bushings were formerly of high strength gray iron.

International Nickel Co. and Cooper-Bessemer

Flame hardened ductile iron ring gear, with hub, flange and gear cast integrally. The gear was formerly a steel forging.

International Nickel Co. and Black Clawson Co.



Glass is another material which should be considered. The tempered variety has good impact strength and is being used in industry for drying racks, chutes, tanks, and doors.

Protective Coatings—Loss of metal due to corrosion can be reduced by the use of protective coatings. New plastic base paints and enamels will protect exposed surfaces and prolong service life. Strippable coatings offer protection in storage. Galvanizing and electroplating will also increase resistance to corrosion.

DUCTILE IRON

Here is a material suitable for many uses formerly served by steels. It offers a combination of the process advantages of cast iron and the product advantages of cast and forged steel. Ductile iron contains only minute percentages of the critical metals. Some of its outstanding properties are:

1. An elastic modulus of 25 million psi compared to 15 to 18 million for ordinary cast iron and 30 million for steel.
2. Tensile strength ranging from 60,000 to 150,00 psi.
3. Machinability equal to cast iron. When annealed it can be machined at two to three times the rate of gray iron.
4. Satisfactory weldability.
5. Capability of being surface chilled to provide a hard, carbidic, abrasion resistant surface with a tough ductile core.
6. The good corrosion resistance normally found in cast iron.

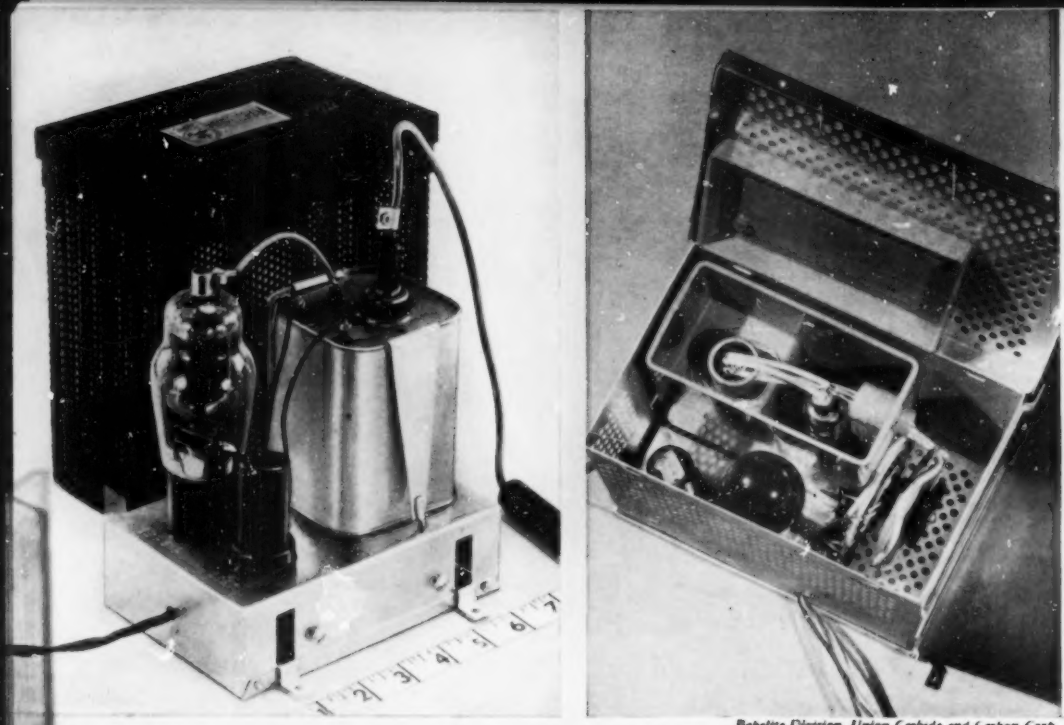
These unique physical properties are attributed to the spheroidal graphite formation in the metal structure instead of the common flake formation. Magnesium is used to control the shape of the graphite.

The development and application of this material is not new. Several years experience by some industries have proven its versatility and advantages. Forged steel generator shafts 7 feet long were replaced by ductile iron shafts by one company because of its superior properties and lower cost. Gear racks of ductile iron have been found to resist the wear and pitting experienced with forged medium carbon steel. Savings in initial cost and in machining in this application were estimated at 60 per cent.

The combined good strength and resistance to wear and corrosion of the ductile iron is attainable only with the highly alloyed steels and non-ferrous metals. Consequently its use as a replacement for these materials should be considered.

Other applications of ductile iron include machine tools, valves, pumps, compressors, pipes, electrical machinery, furnace parts, and heavy industrial equipment such as rolls and rolling mill housings.

The chemical composition of ductile cast iron as used in these applications was modified to meet requirements. By such modification and choice of metal used to control the graphite, a wide range of mechanical properties can be obtained.



Bakelite Division, Union Carbide and Carbon Corp.

High voltage power unit for television receivers. The original model, left, was oil filled and hermetically sealed. A phenolic housing now is used, right. Oil impregnation is not necessary because of the high dielectric quality of the plastic.

Versatility of Plastics

FEW industries attract as much interest during critical periods as the plastics industry. The shortage of metals and the high production rates obtainable with plastics are two major reasons. In addition to an increased demand, especially in the electrical industry, for standard plastic applications, there is now a new demand for plastics as a replacement for metals. Add to this the defense requirements and the burden put on the plastics industry becomes obvious.

AVAILABILITY

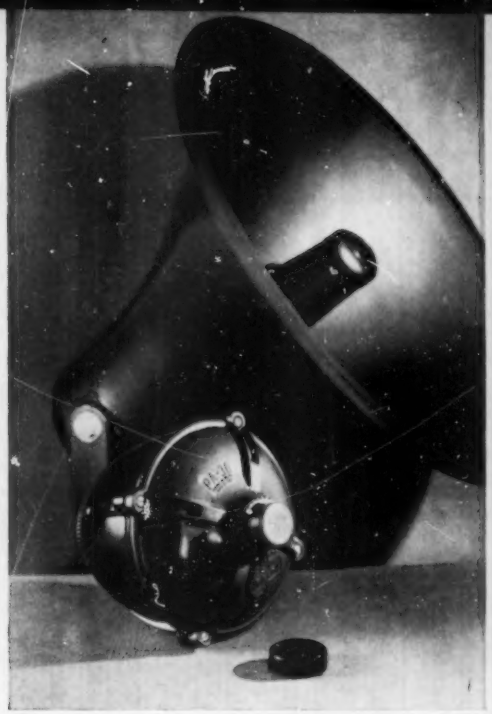
Conflicting reports on the present and expected availability of plastics have resulted in considerable confusion. One bright outlook, however, remains—the eagerness of the industry to expand facilities for the production of more raw materials. Most of the large plastic and chemical companies have major expansion programs under way.

The increasing phenol and benzene production capacity is expected to result in a 35 percent increase in available phenolic powder by the fourth quarter of 1951. Barring unexpected demand by the military the phenolic shortage should be relieved considerably early in 1952. Special materials such as the mica-filled, high impact, and colored phenolics will probably continue in short supply.

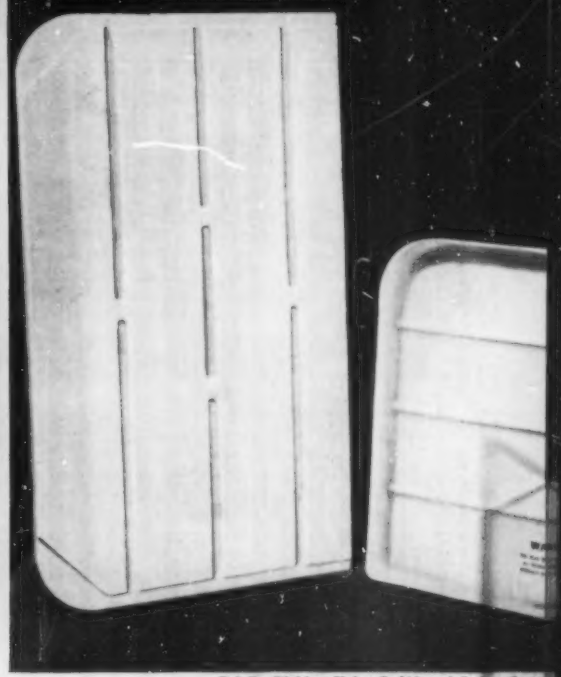
Polystyrene is under complete allocation. The shortage is attributed to insufficient benzene and styrene monomer capacity. The latter material is tied directly to the synthetic rubber program. Increased availability of styrene is expected through expansion of production and relaxation of the government rubber program. Additional benzene sources are expected from production of synthetic benzene from petroleum.

The cellulosic manufacturers anticipate relief as a result of this year's huge cotton crop, which should give them a 60 per cent increase in their supply of cotton linters.

The glass fiber reinforced polyesters



Phenolic molding plastic has replaced metal for the bottom housing of a public address system, at a saving of 25 percent.



Bakelite Division, Union Carbide and Carbon Corp.

Glass reinforced plastic refrigerator parts have advantages over metal parts, such as light weight and mar resistance.

Draws Industry's Interest

are dependent upon the supply of fibrous glass, catalysts and polyester resins. New plants now being built for the production of fibrous glass should alleviate the current shortage of this material. Catalyst supply is threatened by a shortage of high strength hydrogen peroxide. Of the polyester resins the glycols are at present the most available. Shortages of maleic anhydride and phthalic anhydride and of styrene have become alarming to the reinforced polyester industry. Since only a little over one percent of the total production of these resins is consumed in the manufacture of the reinforced polyesters, it remains a matter of getting the government to divert this amount to the industry.

Other plastic materials are generally in tight supply—though in many cases not impossible to obtain. The fact remains, however, that relief is anticipated for plastics prior to the major engineering metals. Consequently engineers will do well to investigate the plastics as possible alternates for metals.

REPLACEMENT CONSIDERATIONS

The effective replacement of metals with plastics requires an intelligent interpretation of the properties of plastics. Some of their essential features which must be considered in mechanical design are as follows:

1. Low tensile strength—generally not exceeding 12,000 psi. Exceptions are the reinforced phenolics and polyesters.
2. Susceptibility to cold flow and creep. The latter characteristic is of concern in metals for high temperature applications. Plastics exhibit these properties at room temperature and under light loads. The resultant deformation must be taken into consideration in mechanical design.
3. Low modulus of elasticity. Increase in section thickness beyond that needed to withstand the applied load is required to provide greater stiffness.
4. High water absorption. This prop-

PROPERTIES OF 17 POPULAR MODERN RIGID PLASTICS

The materials are arranged in order of increasing specific gravity, number 1 being the lightest, number 17, the heaviest. For other properties the materials are numbered in order of desirability. For property values the upper numbers indicate a range of values and the lower numbers an average.

MATERIALS (Molded unless otherwise noted)			ASTM TEST (Jan. 1947)	POLYSTYRENE	ETHYL CELLULOSE	NYLON	METH-ACRYLATES	METH-ACRYLATES (Cast)	CELLULOSE PROPIONATE	CELLULOSE ACETATE-BUTYRATE	PHENOLICS (Cast)	ALLYLS (Cast)	POLYVINYL CHLORIDE	CELLULOSE ACETATE	VINYL CHLORIDE-ACETATES	PHENOLICS	CELLULOSE NITRATE	MELAMINES	UREAS	VINYLIDENE CHLORIDE
TYPE: Thermoplastic—P, Thermosetting—S				P	P	P	P	P	P	P	S	S	P	P	P	S	P	S	S	P
PROPERTIES		UNITS																		
SPECIFIC GRAVITY			D792-44T	1.04-1.07	1.07-1.18	1.14-1.15	1.16-1.20	1.18-1.20	1.17-1.22	1.10-1.24	1.30-1.34	1.32-1.34	1.7-1.4	1.29-1.37	1.30-1.37	1.30-1.45	1.35-1.60	1.40-1.55	1.45-1.55	1.65-1.72
MECHANICAL				1.05 (1)	1.14 (2)	1.15 (3)	1.18 (4)	1.19 (5)	1.20 (6)	1.21 (7)	1.32 (8)	1.33 (9)	1.5 (10)	1.33 (11)	1.33 (12)	1.37 (13)	1.42 (14)	1.47 (15)	1.50 (16)	1.69 (17)
TENSILE STRENGTH		Lbs./Sq. In.	D638-40T	5000-9000	3000-8000	9000-10500	5000-10000	6000-9000	2800-6000	1400-6700	3000-9000	5000-6000	1000-9000	3000-10000	4500-8500	*5000-9000	3000-10000	5000-10000	6000-13000	3000-7000
				6000 (8)	5000 (13)	10000 (1)	7500 (7)	7500 (9)	4600 (15)	5000 (14)	5000 (13)	5500 (12)	5000 (16)	6000 (9)	7500 (7)	7500 (7)	8000 (8)	9000 (3)	9000 (2)	5000 (5)
COMPRESSIVE STRENGTH		Lbs. Sq. In.	D695-44T	12000-17000	8000-20000	14000-18000	10000-15000	11000-13000	6000-14000	3000-23000	5000-25000	21000-23000	?	5000-33000	9000-11500	15000-33000	20000-30000	25000-35000	20000-30000	7500-8500
				13500 (9)	13000 (14)	16000 (2)	13500 (11)	12000 (12)	9000 (15)	14000 (10)	13000 (11)	22000 (1)		19000 (4)	10000 (14)	23000 (4)	25000 (1)	30000 (2)	25000 (2)	8000 (6)
FLEXURAL STRENGTH		Lbs. Sq. In.	D650-42T	5000-19000	4000-12000	11000-13000	12000-19000	10000-16000	4800-10000	4000-12000	3000-14000	8000-13000	?	2000-16000	7500-14000	6000-16000	6000-15000	8000-16000	10000-17000	4000-16000
				11000 (7)	7000 (14)	12500 (3)	13000 (5)	13000 (6)	7400 (13)	8000 (10)	8000 (9)	10000 (8)		8800 (11)	10600 (10)	11000 (6)	14500 (3)	15500 (2)	11000 (4)	9000 (5)
TOUGHNESS (IMPACT)		Ft. Lb. In. Notch	D256-43T	0.25-0.45	1-11	0.6-0.96	0.2-0.4	0.2-0.6	0.8-11.4	0.5-9.5	0.25-0.6	0.2-0.6	?	0.4-6.0	0.25-0.30	0.2-6.0	2.0-8.0	0.24-1.5	0.24-0.36	0.3-4.0
				0.3 (14)	5.0 (2)	0.8 (9)	0.35 (12)	0.4 (11)	1.8 (3)	4.0 (4)	0.35 (13)	0.85 (8)		2.0 (7)	0.28 (15)	2.0 (6)	5.0 (1)	0.38 (13)	1.0 (10)	
HARDNESS		Rockwell M Scale	D785-44T	60-95	20-110	80-90	60-112	60-100	63-104	33-120	20-100	95-115	?	20-120	?	85-130	26-120	112-122	118-122	50-65
				80 (8)	50 (14)	85 (9)	70 (10)	70 (11)	82 (7)	70 (12)	65 (13)	105 (4)		60 (15)		110 (3)	80 (9)	116 (2)	120 (1)	57 (16)
ELECTRICAL																				
DIELECTRIC STRENGTH		Volts/Mil	D149-44	450-650	400-600	300-400	400-500	400-500	370-425	250-400	150-450	500-1000	300-1000	250-450	380-425	250-450	300-550	300-450	250-400	300-500
				480 (5)	975 (4)	378 (12)	480 (7)	480 (6)	395 (10)	380 (11)	300 (14)	800 (1)	500 (3)	399 (9)	404 (8)	398 (8)	435 (2)	378 (11)	340 (15)	390 (6)
DIELECTRIC CONSTANT	60 Cycles		D150-46T	2.5-2.6	3.0-4.0	4.0-5.0	3.0-4.0	3.4-4.0	3.6-3.8	3.5-6.4	10-30	3.45	5.5-9.1	3.5-7.5	3.2-3.3	5-15	6.7-7.3	6.5-9.0	7.0-9.5	3.0-4.0
				2.6 (1)	3.4 (3)	4.8 (8)	3.6 (2)	3.6 (4)	3.7 (7)	4.0 (5)	16 (12)	3.45 (6)	7.3 (11)	5.8 (9)	3.3 (10)	10 (14)	7.0 (13)	7.8 (15)	8.2 (16)	4.0 (9)
	10^3 Cycles		D150-46T	2.5-2.6	3.0-4.0	4.0-5.0	3.0-3.5	3.2-3.4	3.6-3.8	?	10-18	3.25-3.8	4.2-5.5	3.5-7.0	3.1-3.2	4.5-15	?	7.6-8.7	6.3-9.0	3.0-3.0
				2.6 (1)	3.3 (2)	4.3 (9)	3.3 (3)	3.3 (4)	3.7 (7)		15 (12)	3.6 (6)	4.7 (11)	5.0 (10)	2.48 (8)	6.8 (14)		8.0 (15)	7.7 (13)	4.8 (5)
	10^6 Cycles		D150-46T	2.5-2.6	2.5-4.0	3.4-4.0	2.7-3.3	2.5-3.2	3.3-3.5	3.2-6.2	5-11	3.60	3.3	3.2-7.0	3.0-3.1	4.5-10	6.0-6.2	4.8	6.3-7.8	2.3-3.0
				2.6 (1)	3.4 (2)	3.9 (10)	3.1 (3)	3.0 (5)	3.4 (7)		9.0 (12)	3.6 (6)	3.3 (8)	5.0 (11)	2.85 (9)	7.2 (13)	6.1 (14)	4.8 (15)	7.0 (16)	2.6 (17)
POWER FACTOR	60 Cycles		D150-46T	.0001-.0002	0.005-0.03	0.014-0.05	0.047-0.07	0.05-0.06	.004-.008	0.01-0.04	0.02-0.5	0.019	0.01-0.15	0.01-0.06	0.007-0.01	0.01-0.30	0.06-0.15	0.03-0.1	0.035-0.12	0.03-0.08
				0.0002 (1)	0.01 (4)	0.03 (9)	0.06 (13)	0.055 (11)	0.006 (3)	0.025 (7)	0.25 (15)	0.019 (5)	0.09 (12)	0.025 (6)	0.009 (2)	0.20 (14)	0.10 (10)	0.06 (12)	0.05 (16)	0.005 (9)
	10^3 Cycles		D150-46T	.0001-.0002	.005-.025	0.02-0.05	0.04-0.07	0.05-0.06	.008-0.014	0.01-0.06	0.01-0.30	0.01-0.019	0.1-0.16	0.01-0.06	0.011-0.013	0.007-0.40	?	0.015-0.035	0.035-0.055	0.03-0.15
				0.0002 (1)	0.012 (3)	0.03 (7)	0.055 (14)	0.055 (11)	0.011 (2)	0.025 (6)	0.25 (15)	0.014 (4)	0.13 (12)	0.014 (5)	0.013 (8)	0.08 (13)		0.045 (10)	0.045 (9)	0.07 (16)
	10^6 Cycles		D150-46T	.0002-.0002	0.010-0.04	0.04-0.07	0.015-0.03	0.02-0.03	.019-0.029	0.01-0.04	0.01-0.10	0.06	0.10	0.01-0.10	0.018-0.019	0.003-0.06	0.06-0.15	0.02-0.05	0.027-0.04	0.03-0.065
				0.0010 (1)	0.025 (3)	0.04 (9)	0.02 (5)	0.025 (4)	0.024 (2)	0.025 (6)	0.06 (12)	0.06 (13)	0.06 (11)	0.04 (7)	0.018 (8)	0.06 (10)	0.11 (14)	0.042 (8)	0.03 (3)	0.045 (15)
OPTICAL																				
LIGHT TRANSMISSION		%	D791-46T	88-92	0-90	Translucent to Opaque	90-92	90-92	Transparent to Opaque	75-95	5-90	89-92	Transparent to Opaque	80-92	Transparent to Opaque	Opaque	86-91	Translucent to Opaque	21-60	Translucent to Opaque
				90 (2)	50 (3)		91 (1)	91 (1)		85 (4)	50 (7)	91 (7)		88 (3)			89 (4)		30 (6)	
REFRACTIVE INDEX		N_{D20}	D542-42	1.59	1.47	1.53	1.49-1.51	1.49-1.52	1.475-1.490	1.46-1.49	1.58-1.66	1.50-1.57	?	1.46-1.50	1.52-1.53	1.5-1.7	1.50-1.52	1.54-1.56	1.6-1.7
				1.59 (2)	1.47 (14)	1.53 (7)	1.49 (11)	1.49 (12)	1.48 (16)	1.47 (15)	1.6 (3)	1.52 (8)		1.49 (9)	1.53 (6)	1.6 (4)	1.51 (10)	1.6 (5)	1.54 (13)	1.61 (1)
COLORING POSSIBILITIES				Unlimited	Unlimited	Natural & Black	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Strong Dark Colors	Unlimited	Transl. Pastel to Br. Opaque	Transl. Pastel to Br. Opaque	Bright Opaques
THERMAL																				
HEAT INSULATION (THERMAL CONDUCTIVITY)		Cal./cm.^{2}/sec./°C./cm. x 10^{-4}		1.90	4-6	6.0	4-6	2-6	4-8	4-8	3-5	4.8-5.0	3.4-4.0	4-8	4.0	3-15	3.1-8.0	8.4	7.0-7.1	2.2-3.0
				1.80 (1)	5.0 (9)	6.0 (12)	5.0 (9)	4.0 (4)	6.0 (14)	6.5 (13)	4.0 (3)	4.9 (5)	3.7 (11)	4.8 (6)	4.0 (4)	4.6 (8)	4.8 (7)	8.4 (16)	7.0 (15)	2.4 (2)
SPECIFIC HEAT		Cal./°C./gm.		0.32	0.30-0.75	0.40-0.55	0.35	0.35	0.3-0.4	0.3-0.4	0.3-0.4	0.26-0.55	0.3-0.5	0.3-0.45	0.24	0.3-0.4	0.34-0.50	?	0.4	0.32
				0.32 (2)	0.5 (13)	0.45 (11)	0.35 (6)	0.35 (4)	0.3 (3)	0.28 (1)	0.28 (2)	0.45 (14)	0.40 (7)	0.40 (9)	0.24 (1)	0.35 (5)	0.4 (8)		0.4 (10)	0.32 (2)
HEAT EXPANSION (COEFFICIENT OF LINEAR THERM. EXP.)		Per°C. x 10^{-5}	D696-44	6-8	10-18	10.0-10.3	7-9	7-10	12-19	11-17	5-15	5.6-11	?	6-16	6.9	2-7.5	9-16	2-4.3	3-4.5	16-19
				7.0 (3)	14 (12)	10.2 (16)	8.0 (6)	8.0 (7)	15.8 (15)	14 (14)	10 (5)	8.0 (9)	11 (8)	11 (8)	4.9 (4)	4.0 (2)	13.8 (13)	3.0 (3)	3.6 (5)	18 (17)
HEAT DISTORTION		°F.	D648-45T	165-200	110-200	165-170	150-200	140-195	120-160	100-210	95-170	110-225	170-250	110-200	125-135	230-350	110-180	250-400	180-280	150-200
				175 (2)	148 (14)	160 (6)	170 (4)	160 (11)	140 (12)	148 (13)	139 (14)	150 (7)	200 (5)	152 (10)	130 (15)	300 (1)	150 (9)	260 (1)	190 (8)	165 (9)
FLAMMABILITY																				
IGNITED BY FLAME				Readily	Readily	Moderately Easily	Readily	Readily	Unreported	Readily	Very Difficult	Unreported	Unreported	Readily	Very Difficult	Very Difficult	Very Readily	Difficult	Difficult	Difficult
BURNING RATE		In./Min.	D635-41T	0-1.12	1.0	Very Low	0.5-1.0	0.5-1.0	Low	1.5	Unreported	0.3	0.4-0.6	0.4-0	Nil	Very Low	10-25	Nil	Very Low	Self Extinguishing
				1.12 (2)	1.0 (4)	Low (1)	0.75 (5)	0.75 (6)		1.5 (3)		0.3 (1)	0.5 (6)	2.0 (2)			20 (14)			(1)
DUST EXPLOSION HAZARD				Slight Hazard (3)	Some Hazard (5)	Almost no Hazard (1)	Slight Hazard (4)	Slight Hazard (4)	Some Hazard (5)	Some Hazard (5)	Some Hazard (6)	Dust Ready Enc. (7)	Almost No Hazard (2)	Some Hazard (5)	Almost No Hazard (2)	Some Hazard (6)	Dust Ready Enc. (7)	Moderate Hazard (7)	Moderate Hazard (7)	No Hazard (1)
STABILITY																				
WATER ABSORPTION		% 24 hr. at 25° C.	D570-42	0.04-0.06	0.7-2.5	1.5	0.3-0.6	0.3-0.6	1.0-1.7	1.0-2.5	0.5-2.0	0.03-0.20	0.1-0.6	1.0-7.0	0.05-0.15	0.03-3.0	0.5-4.0	0.1-1.7	0.5-3.0	0.0-1.0
				0.05 (1)	1.8 (12)	1.5 (13)	0.45 (7)	0.4 (6)	1.35 (15)	2.0 (16)	1.3 (14)	0.13 (4)	0.35 (9)	4.0 (11)	0.12 (3)	0.8 (9)	2.0 (14)	0.6 (8)	2.0 (14)	0.05 (2)
RESISTANCE TO: (conc.—concentration)	WATER			Excellent	Good	Good	Excellent	Excellent	Good	Good	Excellent	Excellent	Excellent	Fair	Excellent	Excellent	Good	Excellent	Fair	Excellent
	*ACID			All Conc.	Attacked	Low Conc.	Low Conc.	Low Conc.	Low Conc.	Attacked	Attacked	All Conc.	Low Conc.	Low Conc.	Low Conc.	Low Conc.	Low Conc.	Low Conc.	Low Conc.	All Conc.
	ALKALI OR CAUSTIC			All Conc.	All Conc.	All Conc.	Low Conc.	Low Conc.	Low Conc.	Attacked	Low Conc.	All Conc.	All Conc.	Low Conc.	All Conc.	Low Conc.	Low Conc.	Low Conc.	Low Conc.	All Conc.
*Except Oxidizing Acids	ORGANIC SOLVENTS			Lower Alc. & Oils	Soluble	Except Phenols	Except Chlorinated Hydrocarbons, Ketones and Esters		Exc. Ketones & Esters	Attacked by some	Attacked	No Effect	Exc. Ketones & Esters	Petroleum Solv. only	Exc. Ketones & Esters	Variable to Insoluble	Hydrocarbons Only	Color Bleed Only	Color Bleed Only	Exc. Chlorinated Hydrocarbons
DEFORMATION UNDER LOAD		% 24 hr.	D621-45T	0.5-5.0	?	4.0-4.5	?	?	?	11.8-37.1	?	?	10-15	6.3-13.3	?	?	20-60	?	?	9.5
				1.8		4.25				24.46			12	10.8			65			9.5
EFFECT OF SUNLIGHT				Slight Yellowing	Slight Darkening	Slight Discoloring	Very Slight Yellowing	Very Slight Yellowing	Slight Change	Slight Change	Yellows	Slight Yellowing	Darkens	Slight Discoloring	Darkens	Slight Darkening	Discolors	Slight Darkening	Slight To None	Slight Darkening

Koppers Co., Inc.

erty is listed as the percent increase in weight resulting from a 24 hour immersion—not to saturation. A dimensional change, usually an increase, also results and where intermittent or continuous immersion in water is expected, this change must be considered.
5. High coefficient of thermal expansion. Here again the dimensional changes due to temperature variations, even below 212 F, are generally large enough to be a factor in design.

For many applications tolerances can be adjusted to allow for thermal and moisture effects.

6. Low heat resistance. By the incorporation of various heat resistant fillers the thermosetting resins can be made to withstand up to 400 F. However 150 F is considered the top service limit of plastics.

The above features do not preclude the use of plastics as metal replacements. Their consideration, however, can prevent misapplication which has previously plagued the plastics industry as well as the consumer.

Many advantages are to be gained by the use of plastics. Where aqueous corrosion resistance is a major requirement plastics are usually superior to metals. For resistance to strong chemicals a choice can be made among the plastics. Light weight, low cost, ease of fabrication are other advantages.

SPECIFIC MATERIALS AND THEIR APPLICATIONS

The glass fiber reinforced polyesters are one of the newest and most outstanding of the plastics. This material has high tensile and impact strength, good corrosion resistance and good electrical properties. It can be fabricated at low pressure and temperature using low cost molding equipment. Large complex structures can be molded.

The reinforced polyesters can effectively replace steel and aluminum in many applications. Some present uses are boat hulls, battery cases, radomes, airplane wing structures, salt water piping and typewriter cases.

The phenolics and the phenolic-elastomer combinations can be molded to close tolerances and have high impact strength and good heat resistance. Metal has been replaced by these materials in such applications as containers, flash-light holders, small gears, pulleys and handles. Many units now fabricated from sheet metal can be successfully and economically molded of phenolic resin.

Nylon is a valuable engineering material due to its toughness, wear resistance and self lubrication. It has replaced steel and copper alloys for bearings, cams and gears. For aqueous service its high water absorption must be considered where close tolerances are required.

Polystyrene, when made available, will find many applications. Improvements have been made in impact and heat resistance. This material is considered the lightest and most economical of the plastics. Some of its other advantages are low water absorption, retention of properties at low temperatures, and adaptability to mass production through injection molding. The development of the large capacity injection molding machines will further expand the use of this material. Such molded items as television cabinets, refrigerator doors and bathroom fixtures are now being planned for single shot styrene molding.

Post molded treatments such as annealing and destaticising and the decorative techniques of lacquering and metallizing have added to the usefulness and attractiveness of polystyrene.

The vinyl plastics can be used to advantage as protective coatings or liners for metal parts subject to corrosive conditions. The vinyls are noted for their toughness, wear resistance and chemical inertness.

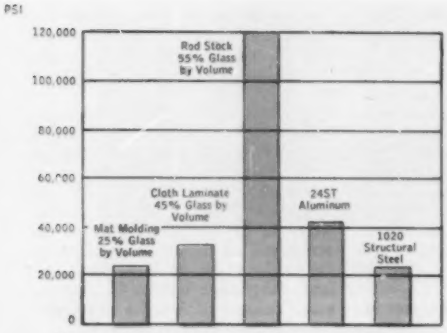
Rigid polyvinyl chloride, produced from vinyl-chloride-acetate resins, has good strength and dimensional stability. It is resistant to most organic chemicals, strong alkalies, salts, inorganic acids, alcohols, gasoline, kerosene and animal, mineral and vegetable oils. This rigid thermoplastic sheet material can be fabricated into complicated shapes. Permanent bonds are secured by heat-sealing or solvent-sealing. It can replace some of the highly alloyed steels and non-ferrous metals for special corrosion resistant tanks or containers. It's odorless, tasteless and non-toxic properties meet the standards required for food containers.

Joining of metals, and metals to non-metals by plastic adhesives can help conserve the hard-to-get metal fastening materials such as rivets, welding rod and mechanical fasteners. The phenolic adhesives and the newer epoxy adhesives produce good high strength bonds.

The use of bonding resins in sand molds can effect metal savings in the foundry. The Croning Process employs thin-shell, single use sand molds bonded with phenolic resins. A thin coating of the sand-resin mixture is applied to the surface of a heated metal pattern and subsequently baked hard to form a mold half. The two halves are clamped together in a flash and surrounded by metal shot or similar bedding material in preparation for casting the metals.

Tolerances of 0.002 to 0.003 inches per inch have been attained with this process. Castings are clean and rejects are reduced. The resultant reductions in scrap loss and in machining reduce cost and conserve metal.

And last, but of significant importance are plastic foam structures and high strength acrylics, which have large application potential.



Comparative tensile strength of reinforced plastics

Bakelite Division, Union Carbide and Carbon Corp.

Phenolic television deflector yoke, left, replaced cardboard spool assembled from ten separate pieces, right.

Aluminum Output Improves

The Martin XB-51 ground support plane. High strength aluminum alloys are essential in the production of this and other type jet engined aircraft.

Glenn L. Martin Company

SINCE the end of the war, production of aluminum has more than doubled. Compared to 800 million pounds produced in 1946, the 1951 production is estimated to be in excess of 1.6 billion pounds. Planned expansion will raise this total by 1952 to 2.3 billion pounds per year. The government has been stockpiling aluminum at a rapid rate in the interest of national defense. The development of better international conditions might ease the stockpiling program. Under such conditions the aluminum production will be sufficient to alleviate the present shortage. In any event, relief is expected for aluminum long before steel and copper. Consequently proposed substitution of aluminum for these metals should be considered.

Recent technical and market developments in the aluminum industry have quelled the fears of overproduction in the event of defense relaxation. Some of these developments will be considered to present the added potentialities of aluminum as an engineering material. They might also serve to enlighten prospective users of aluminum as an alternate to steel and copper alloys.

Technical Developments — Stronger wrought alloys containing magnesium and zinc and minute quantities of copper and chromium are now being used in aircraft construction. These alloys, 75S and the more recent 78S, can be heat treated and aged after fabrication. They are not subject to intergranular corrosion which has previously limited the field of application of this type alloy.

Aluminum rivets with a shear strength of 38,000 psi were developed last year. They are suitable for heavy duty use in aluminum structures. Their higher strength means fewer rivets per joint with resultant lower cost and greater saving of metal.

Sheet aluminum, with steel backups, is being considered for sleeve bearings. Special alloys have been developed for this purpose.

Significant advances have been made in the processing of aluminum alloys. Hollow and impact extrusion techniques have advanced significantly within the last year. Hollow extrusions can be made with five or six completely enclosed hollow areas. Impact extrusions of larger and more complicated shapes are being developed. Application of the Marform and Hydro-form processes will result in lower cost fabrication.

Advances in joining techniques include improved flash welding and semi-automatic and automatic shielded-metal arc welding. The latter uses an aluminum filler wire that is continuously fed in an inert gas atmosphere.

Cold welding is expected to find use in fabrication of parts from sheet aluminum. This process is being used to advantage in Europe to supplant soldering, welding, and the use of fasteners.

Color anodizing will increase the use of aluminum in the architectural and consumer fields. It will be a major factor in the competition between aluminum and plastics.

Prospective Fields of Application— Aluminum automobile bodies are a future possibility. Increased cost of rubber and gasoline are incentives to the production of lighter cars. A weight saving of 20 per cent was obtained in the construction of an experimental aluminum body through the combined efforts of Willys Overland, Progressive Welder Co., Aluminum Company of America and Good-

year Aircraft Corporation. Actually, the conversion to aluminum bodies by the automobile companies would absorb the total present aluminum production. This program will therefore probably progress slowly. At present aluminum is being used in the automobile field for door frames, headlamp housings, radiator shells, heater fan blades and running boards. Most of these items were formerly made of steel.

Another potential market for aluminum has been opened by the introduction into this country of a process for photographing directly on anodized aluminum sheet. Applications include dial faces, instrument panels, signs, slide rules and permanent documents.

Substitution Considerations—The serious shortage of copper and the dark outlook for its future availability will increase the demand by the electrical industry for aluminum because of its light weight and good conductivity. Although a volume equal to about 1.5 times that of copper is needed to give equal conductivity, the total weight of aluminum will be only half the weight of copper. Applications will include bus bars, cables and some electrical components. These substitutions will depend, of course, upon availability.

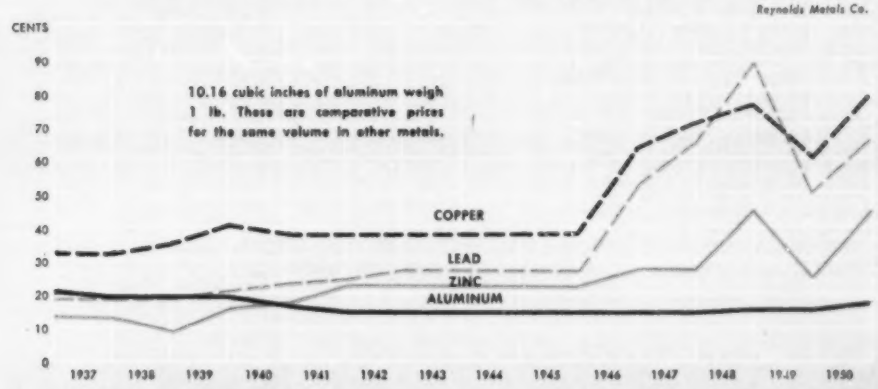
Substitutes for aluminum must be considered in the event that sudden increased demands for this metal are made by the government. The glass reinforced plastics have the light weight, good corrosion resistance and high strength needed for some applications. Where light weight is of secondary importance zinc die castings should be considered.

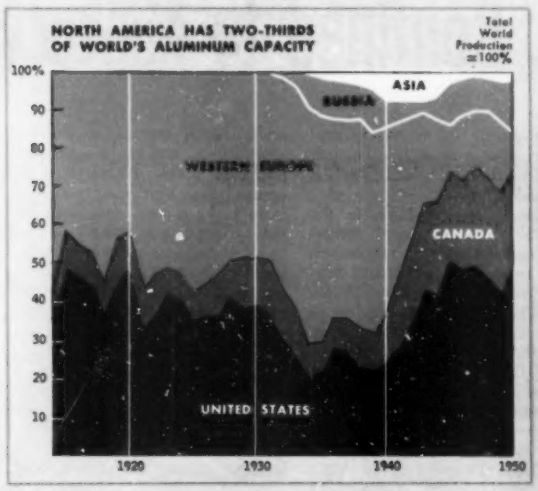
ACKNOWLEDGMENTS

Reynolds Metals Company, Revere Copper and Brass, Inc.

COMPARATIVE VOLUME PRICES OF ALUMINUM, LEAD, COPPER AND ZINC

Reynolds Metals Co.

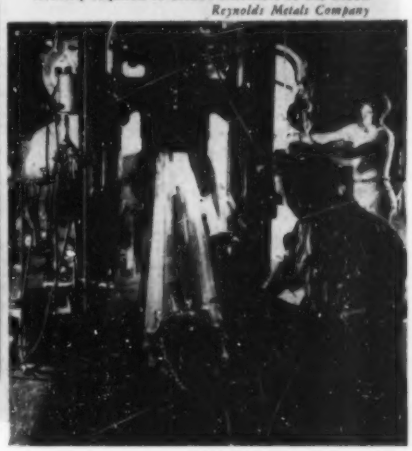




Reynolds Metals Co.

Aluminum is forced through die openings under pressures as high as 5,500 tons to produce extruded shapes. The tube shown here will be slit and flattened to produce a sheet with integral stiffeners for aircraft applications. Thousands of rivets were formerly required to attach stiffeners to the sheet.

Reynolds Metals Company



COMPARATIVE PROPERTIES OF SEVERAL Mg-Li BASE ALLOYS

Property**	Low-Strength Alloy	Medium-Strength Alloy					Commercial Alloys	
	Mg-Li Alloy No. 1	Mg-Li Alloy No. 2	Mg-Li Alloy No. 3	Mg-Li Alloy No. 4	Mg-Li Alloy No. 5	Mg-Li Alloy No. 6	75S T Alclad	AZ31X-h
Composition	9.1 Mg/Li binary	8.1 Mg/Li-2% Al	9.5 Mg/Li-7% Al-1% Sn	6 Mg/Li-15% Cd-5% Ag	6 Mg/Li-4% Zn-6% Cd-8% Ag	7 Mg/Li-2% Zn-16% Cd-4% Ag	5.6% Zn-2.5% Mg, 1.6% Cu-0.3% Cr, bal. Al	3% Al-1% Zn-0.3% Mn, bal. Mg
Density, g./cc.	1.47	1.48	1.56	1.70	1.72	1.79	2.80	1.77
Resistance to corrosion*	B	B	B	C	(C)	(C)	A	B
Susceptibility to stress corrosion in normal atmosphere*			B				A	B
Tensile strength, psi	18,000	23,800	47,000	46,000	60,000	59,500	76,000	42,000
Tensile Yield strength, psi (0.2% offset)	14,500	18,400	36,000	42,000	55,400	55,400	67,000	33,000
Compressive yield strength, psi	(14,500)	(18,400)	(36,000)	42,000	55,400	55,400	67,000	26,000
Elongation, % in 2 in.	50	36	6	6	1	3	11	11
Tensile strength divided by density	12,500	16,100	30,200	27,100	35,400	33,200	27,200	24,300
Tensile yield strength divided by density	9,900	12,400	23,100	24,700	32,200	31,000	23,900	18,700
Compressive yield strength divided by density	9,900	12,400	23,100	24,700	32,200	31,000	23,900	14,700
Tensile modulus of elasticity divided by density****	(4,430,000)	(4,390,000)	4,170,000	3,820,000	3,700,000	3,630,000	3,680,000	3,670,000
Density divided by $^3\sqrt{E}$ on basis that the value for 75S-T = 1	–	–	0.65	0.71	0.71	0.75	1.0	0.74
Stability at 200 F.	A	A	B	C	C	C	A	A
Cost of material per lb. of alloy***	$0.73	$0.72	$0.63	$1.45	$1.55	$1.30	$0.17	$0.21
Notch sensitivity*			C	C	(C)	(C)	A	C
Formability*	A	A	C	A	(A)	(A)	B	C

*A indicates the best; B, the intermediate; C, the poorest.
( ) Indicates estimated value. – Value has no significance. **All values are for sheet material.
***Costs of lithium-bearing alloys are based on lithium cost of $5.00 per lb, the estimated cost for large-scale production.
****The tensile modulus of elasticity for the magnesium-lithium alloys and for AZ31X-h is 6,500,000 psi. The value for 75S-T is 10,300,000 psi.

Magnesium . . . Confined to Military

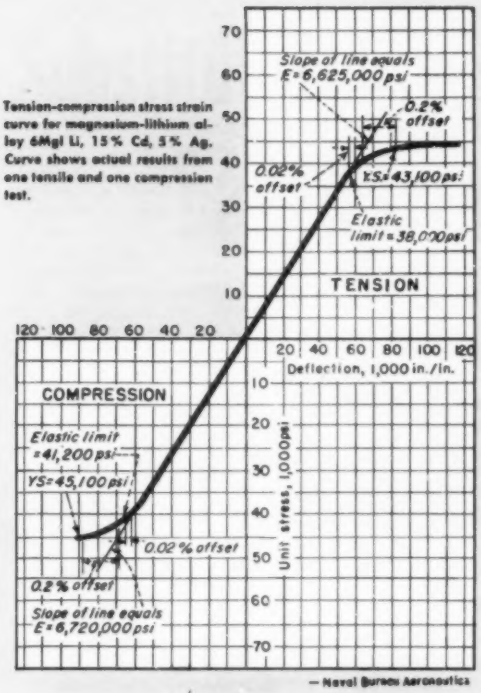
For all except manufacturers engaged in direct military supporting activities, magnesium is practically unobtainable. Starting about a year ago, the government demands for the metal for stockpiling were so high that manufacturers of consumer products were forced to switch from magnesium to aluminum or zinc especially in the case of die castings.

If, as now indicated, additional money is voted for expansion of the Air Force from 90 to 150 groups plus, and guided missile development continues at its present pace, there is little hope in the immediate future that magnesium will be back in good supply. In die castings, the trend was first to aluminum and then to zinc as a replacement. Since lightness is a factor in many magnesium applications, reinforced plastics are another alternative when a substitute for secondary load carrying member is necessary. For primary structural applications, steel is the next hedge.

The Armed Services have, in the past several years, sponsored several programs on high strength magnesium alloys. Magnesium-zinc-zirconium compositions (see PRODUCT ENGINEERING, May, 1951) have received considerable attention. Alloy Mg-6Ag-6Zn-1Zr in 0.200 in. sheet has the following properties: 60,000 psi tensile strength, 48,000 psi tensile yield strength, 40,000 psi compressive yield strength, and 4 percent elongation in the longitudinal direction; and 61,000 psi tensile strength; 49,000 psi tensile yield strength; 39,000 psi compressive yield strength, and 9 percent elongation in the transverse direction.

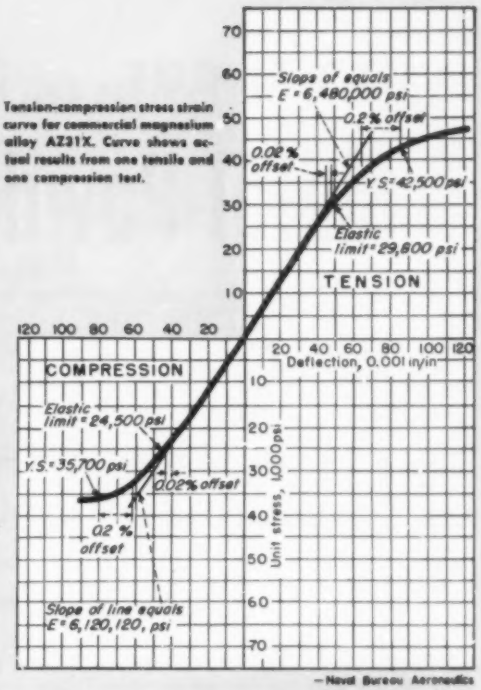
Another series of alloys, developed under Naval Bureau of Aeronautics sponsorship, are the magnesium-lithium base alloys. Although it is recognized that significant problems remain to be solved, and that none of these alloys may be entirely satisfactory in all respects, it is nevertheless a fact that development has progressed sufficiently to indicate that several materials may be of significant design interest.

The chief advantages of magnesium-lithium base alloys as seen at this time over conventional magnesium alloys are lower density, greatly improved compressive yield, and better isotropy with respect to yield strength and elastic modulus. In addition, the lower strength magnesium-lithium base alloys and certain of the higher strength alloys have considerably better formability than commercial magnesium alloys. These characteristics are attrib-



Tension-compression stress strain curve for magnesium-lithium alloy 6Mgl Li, 15% Cd, 5% Ag. Curve shows actual results from one tensile and one compression test.

— Naval Bureau Aeronautics



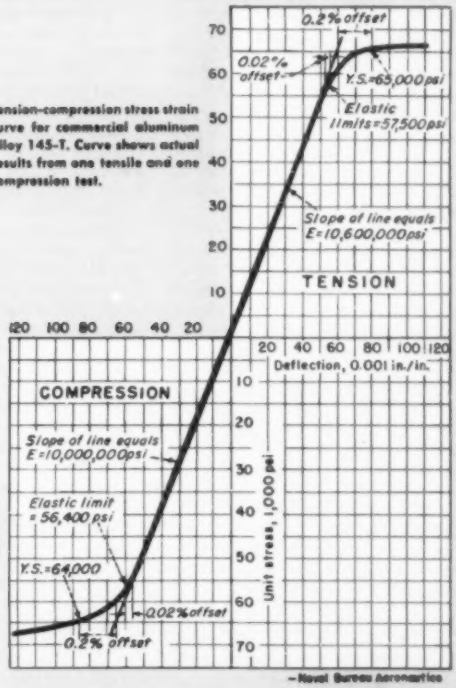
Tension-compression stress strain curve for commercial magnesium alloy AZ31X. Curve shows actual results from one tensile and one compression test.

— Naval Bureau Aeronautics

Applications

uted to the ability of lithium to convert the magnesium lattice from hexagonal to a body centered-cubic structure. The chief disadvantages are that the very high strength magnesium-lithium base alloys, in general, may be suitable only for applications involving temperatures not exceeding 100 to 150 F, since they over-age at temperatures above 150 F at a faster rate than conventional aluminum and magnesium alloys. However, short time exposures at these temperatures may not be detrimental. In addition, the corrosion resistance and impact strength of the very high strength alloys are undesirably low by present standards. The former may be improved significantly, however, by cladding, at least in the case of sheet.

Work is progressing on these as well as other high strength alloys.



Tension-compression stress strain curve for commercial aluminum alloy 145-T. Curve shows actual results from one tensile and one compression test.

— Naval Bureau Aeronautics

WHAT ABOUT

Metal-Powder Parts?

Most powdered metals are less short than fabricated mill products.

A wide range of properties can be obtained in parts made of various alloys.

Machining operations can usually be reduced, and often eliminated.

There is little scrap loss in the powder metallurgy process, and rejections are low.

Porosity can be controlled—production rates are high—unit cost is low.

THE last war gave a great impetus to the powder metallurgy process. Because the same conditions that existed then have appeared again in essentially the same form, this process again appears slated for wider study and adoption, particularly since the use of powder metallurgy represents an excellent hedge against materials shortages and machine tool shortages.

In general, metal powders are controlled to the same extent as fabricated mill products, but the availability of most metals is much better in this form. For example, copper and copper base metal powders are controlled and all orders must be filed and categorized with a defense rating—but copper alloys in this form are in much easier supply than strip, sheet, wire, or rod. The same is true of iron, zinc, or even stainless steel powder.

One of the unusual advantages of powdered metals is that they can be combined with different metals and substances, producing mixtures which are not possible by any other process, such as lead with copper for bearing surfaces; copper with carbon; copper or silver with tungsten for contact points; or combinations of tin, copper iron, lead, graphite asbestos and silica for specialized applications. Inserts of entirely different metals or nonmetals can, of course, be placed in the powder during forming for strength, electrical or other reasons.

Types of Powders

Brass powders are divided into two classes. One contains the irregular shaped particles used in all normal fabrications where good compacting and sintering processes are needed. This type offers a strong mechanical bond. The second type contains spherical shaped particles, which are used where controlled porosity is necessary; particularly in the construction of filters. This type has lower bonding strength, and must be held in the mold during the sintering process.

Copper powders made by the atomization process are spherical in particle shape, and are divided into two grades. The first grade is pure copper with a normal oxygen content. The second is copper plus phosphorous having a low oxygen content. The addition of phosphorous is effective in powders having a low copper content. In a brass powder of 70 percent copper and 30 per cent zinc, phosphorous reduces the optimum sintering temperature from 900 C to 850 C. It also broadens the sintering range from 20 C to 40 C. In a 90-10 brass powder, phosphorous has no effect on the sintering temperature or range. It does increase the ductility, however, as normally would be expected. The important effects of copper show in the sintering oven where the high temperatures cause a change in weight and dimension. Where close control of these two factors are desired, high copper content powders have an advantage.

Bronze powders are difficult to compact, but may be used for fabricating where high density is not required. With the addition of phosphorous the particles are spherical and may be used for filters.

Zinc powders are usually not used for fabrications, because they cannot be produced as economically as zinc die casting production.

Iron powder, containing copper and graphite powders often have tensile strengths as high as 70,000 pounds per sq. inch. Iron alloy parts may also be hardened by the usual methods of heating and quenching, or by nitriding and carburizing. Tensile strengths are then raised to 100,000 psi.

Recently there has been considerable interest in stainless steel parts produced by the powder metallurgy process. Stainless steel and other highly alloyed steel powders are now being produced by Vanadium Alloys Steel Company by water-jet disintegration of the molten metal. The stainless steel powders, Types 310 and 316, can be pressed at normal pressures of 30 to 50 tons per square inch and sintered at relatively low temperatures (2100 F to 2300 F). The high production rates and metal saving advantages of the powder metallurgy process can now be extended to these highly alloyed steels for machine applications.

Substitute Finishes ARE BETTER THAN YOU THINK

IN the field of inorganic finishes, the problem that has received the most attention is the modification of, or the substitution for the conventional copper-nickel-chrome electroplate. Actually, the availability of chromium is not a factor. The problem is created by the shortage of nickel and by the government regulations restricting its use. As a result, one class of substitute finishes that have been developed either use less nickel and more copper; another, less nickel, more copper and a organic lacquer. (See Table I) For outdoor services on products such as automotive bumpers, there is not much doubt that any reduction in the total thickness of the copper-nickel undercoats impairs corrosion resistance. Adding a clear synthetic lacquer or chlorinated rubber over the chromium fills up the cracks that exist in the chromium plate and increases corrosion resistance even if the organic finish peels. But peeling of this top coat creates an undesirable difference in appearance.

The organic coating for these modified chromium finishes must be carefully selected since adhesion to the smooth chrome plate is of primary importance. Either urea-formaldehyde, melamine-alkyd, or clear chlorinated rubber coatings are satisfactory, depending on the properties specified by the user. For touch-up materials, which are a problem for coatings of this sort, an air drying finish with approximately the same color values as the organic top coating is used; over lacquer, a nitrocellulose-acrylic base lacquer is recommended.

All of the above finishes are suitable substitutes providing both chromium and copper plating solutions can be obtained. The general consensus is that chromium will be available but copper might come under additional government restrictions. If such is the case, alternate coatings are thick chromium plates applied directly, or a buffed zinc plate plus a conversion coating and a clear organic finish can be used. Of the two, the latter appears more practical from a cost standpoint, since (1) the thickness of a single chromium plate must be greater than 0.0001 in. to eliminate cracking and porosity; and (2) the best average disposition rate for chromium is about 0.002 in. per hour.

The appearance of a bright zinc-chromate-lacquer finish is surprisingly like a good chromium finish provided the zinc plate is properly buffed. When a part has sharp corners and radii, it may be necessary to first add a thin coat of zinc, buff, apply a final thickness of zinc, buff again, and proceed with the subsequent finishing operations. A deposit of from 0.0002 to 0.0005 in. is required to prevent removal of the plate during buffing.

Of the other electroplates, cadmium is difficult to obtain and the cost is substantially higher than an equivalent zinc plate. So the swing is to zinc. Another possibility is tin-zinc plating which has been popular in Europe but never used extensively here. A tin-zinc electroplate is grey in color, is said to have a better corrosion resistance than zinc, and solders readily. For this latter reason, it is especially applicable for electrical and electronic equipment. However, tin also is in short supply.

Insofar as brass is concerned, a dyed organic finish or a zinc plate with a different type of conversion coating will give a substantially similar appearance. Or still another type of chromate dip can be used to produce a highly reflective black finish over zinc, which may be a satisfactorily substitution for black nickel electroplates.

Another point is worthy of note regarding all electroplates: Frequently a stop-off lacquer can be applied to the back of a product to reduce the amount of plating solution necessary. This coating can be left on the product to provide protection in service.

If substitutes for electroplates as required, however, approach them with caution:

1. Don't proceed without securing the recommendations of one or several suppliers regarding procedures, coating thicknesses, and costs.
2. Don't try to chisel on the thickness of the finish. The plating thickness recommended by a supplier is the minimum that will do the job.
3. Don't buy lacquers for electroplates on the basis of cost per gallon. The percentage of solids governs the cost per sq. ft. of finished surface.
4. Don't buy an ordinary conversion coating for use with automatic plating equipment. A slow speed solution is required to prevent stripping of the plate on long-time immersions.
5. Don't make guarantees based on laboratory tests.

Acknowledgment: United Chromium Corporation.

TYPICAL SUBSTITUTE FINISHES FOR COPPER – NICKEL – CHROMIUM ELECTROPLATES ON STEEL

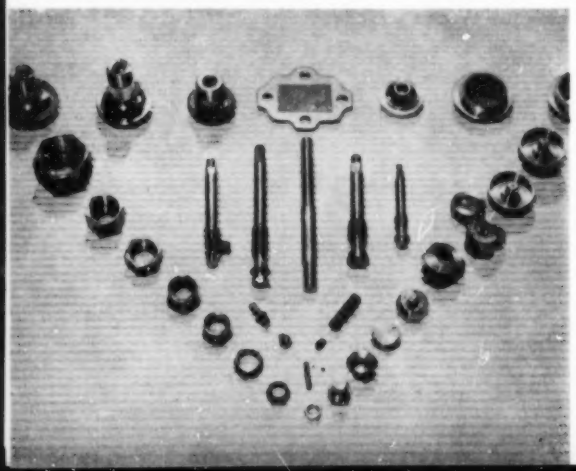
TYPE OF FINISH	THICKNESS OF FINISH, IN.				REMARKS
	COPPER	NICKEL	CHROMIUM	SYNTHETIC LACQUER	
Conventional copper – nickel – chromium	0.00065	0.0006	0.00001	–	Chromium provides appearance value primarily since thin coats are porous. Nickel and copper are used for corrosion resistance and base.
Modified copper – nickel – chromium	0.00105	0.0002	0.00001	–	Reducing thickness of nickel plate and increasing thickness of copper layer probably reduces salt spray resistance, but this still is a high quality finish.
Modified copper – nickel – chromium plus synthetic lacquer	0.00065	0.0002	0.00001	0.0005	Adding a clear organic finish over the chrome fills up cracks in chromium and protects thinner under layers even if lacquer peels.
Modified copper – nickel – chromium plus synthetic lacquer	0.0005	0.0002	0.00001	0.001	Further reducing copper plate thickness may reduce durability of finish, but this is open to argument.
Copper – chromium – synthetic lacquer	0.001	–	0.00002	0.0005	Same as above. Lacquer may sometimes be omitted for indoor service.
Zinc plate plus clear conversion coating plus lacquer	0.003 in. zinc plate and chromate dip solution, such as Iridite, Lusteron, or Unichrome			0.0005	Gives good appearance and corrosion resistance. Without lacquer, will stand up 75 to 100 hr. in salt spray prior to appearance of white corrosion products. Lacquer added to decrease iridescence of conversion coating and increase corrosion resistance of finish. Preferred to above finish by some automotive manufacturers.

COPPER

Copper and Brass Research Association

Inserting copper tubes into condenser used in the oil industry.

Screw machine products fabricated from copper-base alloys.



The copper industry has no satisfied customers. There is not enough material to go around and better days are a long way off. Copper production, especially mining, cannot be increased rapidly. A deficit of 600,000 tons per year is expected for several more years. We will be dependent upon imports for at least one-third of our needs and we will have to meet the world price if we expect to get it. While we supply Europe with copper under the ECA program, they have been outbidding us for copper from Chile and other Western Hemisphere sources.

The government stockpile of over a half million tons of copper is considered adequate by many copper industry officials and it is expected that pressure will be brought upon the government for some stockpiling relaxation.

Demand Is Increasing—Demand for copper and copper-base alloys has been generally upward over the past twenty-five years. A rise in building construction, new electrical devices and increased automobile production have been contributing factors. The electrical industry consumes over 50 per cent of the total supply of copper and the combined automobile and building industries another 25 percent.

Expansion in the oil and chemical industries has given rise to increased consumption of copper for condenser tubes, piping and reaction kettles.

Substitution A Problem—Replacement of copper-base alloys will not be easy. Their good electrical and heat conductivity, corrosion resistance, machinability, high strength, wear resistance and attractiveness are properties not bound to the same degree in other metals. Some conservation can be practiced by resorting to processing techniques which require less metal and produce less scrap. Powdered metals, precision castings, and forgings can be used instead of sand castings. The use of copper-clad steel will also help conserve copper.

The electrical industry can resort to aluminum for some applications. In many cases the increase in size of the aluminum part needed to give conductivity equal to a copper part will require design changes. Such changes will meet considerable opposition. Soldering and insulation are additional problems. Enameling of aluminum has not as yet been successful.

In some cases secondary metal ingots can be obtained for sand cast parts. High purity will have to be sacrificed but for many purposes performance will be satisfactory. The percentage of rejects is liable to be high due to porosity and poor machinability.

Except in the electrical industry the volume of copper which can successfully be replaced is not expected to be large. At least it won't relieve the shortage. Price and politics are more powerful tools. Since the government has contributed to the shortage the copper industry feels it has a right to expect the government to help relieve that shortage.

Acknowledgements

Copper & Brass Research Association; Revere Copper and Brass Company

BRIEFS ON Other Materials

LEAD

Foreign purchases account for 400,000 tons per year of this country's supply. But since the price here is frozen at 17 cents per pound and foreign countries are buying at 21 to 23 cents per pound, about half of the foreign supply is being cut off. Bright spots in the picture are (1) because of the reductions in car output, less lead is going into battery applications; (2) demands for the government stockpile have decreased and (3) there has not been any preponderance of new applications as yet.

Specific substitutions being made as checked by The National Lead Co. are:

In the chemical industry, alloy steels, plastic and rubber coatings and even titanium are being used in place of lead in some applications.

In construction, grey iron castings can sometimes be specified when weight is a factor.

In die castings, zinc has been used instead, although the amount of lead that is die cast is small when compared to such metals as zinc, aluminum, or magnesium.

Organic finishes and electroplates have been substituted for lead alloy coatings.

For batteries, there is no alternate, but about 60 percent of the lead in automobile batteries comes back as secondary metal.

TIN

Tin is another of the critical metals in short supply. Here is how some manufacturers are reducing their requirements for this metal:

Silicon bronzes have been substituted for tin bronzes with considerable success in many applications. American Smelting & Refining Company has accumulated data on such bronzes.

For solder, low tin alloys are being used in place of 50 Sn-50 Pb compositions by adding small amounts of other elements such as antimony or silver. This was standard practice during World War II. Can manufacturers have gone from 70-30 compositions to solders containing only 2-3 per cent tin without harmful effects. In high production jobs, the tendency is to use more expensive solders containing silver or antimony to maintain flowability and lower the melting point. In lower production applications, straight low tin silvers are being used irrespective of higher melting points.

Car and truck body solders are now down to 2-3 percent tin, 4 percent antimony, and remainder lead. The tin contents of solders of commutator segments has been reduced in some instances by 20 percent. For electronic uses alloys containing 5 percent iridium and 30 per cent tin have been used, and when production warrants, circuits can be changed to printed types, thus reducing the demand.

In aircraft radiators, another possible substitute is a 15 to 40 per cent tin alloy in place of pure tin.

In 80 or 90 per cent of babbitt applications, lead base types have proven satisfactory. For high temperature uses, specialized compositions are recommended.

NICKEL

For manufacturers of commercial goods nickel in almost any form is simply unavailable. This is a somewhat exaggerated statement and of course there are exceptions, but the fact is that nickel is one of the metals in tightest supply and availability won't improve in the near future.

As far as wrought or malleable nickel mill products are concerned, availability except for military uses is going to get worse as the defense program moves ahead. Practically all malleable nickel and high nickel alloys are being supplied against DO rated orders. For example, 30 days in advance of a melt month, the International Nickel Company submits a program to the National Production Authority for approval. This program lists each order by item and contains all pertinent data; each order is approved, disapproved, or downgraded.

However, even on rated orders, delivery is four to six months after the order has been approved. For some forms, such as tubular stock, the longer period is required, while plate and hot rolled rod are available in approximately four months.

Some improvement is expected as the result of the development of Incoloy, a lower nickel content material than Inconel.

This new alloy contains about 35 per cent nickel and 20 per cent chromium, with the balance iron. It is produced in most standard rolling mill forms, including sheet, strip, rod, wire and tubing. This alloy is designed for many purposes now served by some of the company's older alloys, which run up to more than 70 percent nickel. Detailed data on mechanical and physical properties are not yet available.

ZINC

In most products, zinc will not be the bottleneck in materials supply. As a matter of fact, conditions today are probably as bad as they will get—and there is still a lot of zinc going in to automobiles, radio and television sets, and other consumer products.

Zinc stockpiling must be nearly completed, as the government is not taking as much now as previously, and if a reasonable attitude is taken, successively smaller percentages will be required for this purpose.

Foreign sources of supply are drying up in some instances, since, as with other metals, the Marshall plan has so inflated the economics of foreign countries that they are offering more than we for zinc concentrates, but this probably will not continue. Cutbacks in the automotive industry and a lag in defense production probably will ease the supply somewhat.

MOLYBDENUM

The United States produces about 90 percent of the world's output of molybdenum. This gives us a substantial advantage strategically because

of the potentialities of this metal in the high temperature alloy field. It is the most abundant of the highly refractory metals—those with melting points above 3,500 Fahrenheit. Our reserves are large and production capacity can be increased considerably.

A look at some of molybdenum's outstanding properties will clarify its strategic importance. It melts at 4,750 F, which is about 1,800 degrees higher than our present high temperature metals. Above 1,700 F it exceeds the strength properties of these materials. The specific heat and coefficient of thermal expansion of molybdenum are about half those of steel, thus providing advantageous heat transfer and thermal shock characteristics. Its electrical conductivity is about one-third that of copper or silver. Only aluminum, gold and magnesium exceed it in this respect. Molybdenum also has a high modulus of elasticity—and it retains it at elevated temperatures.

A serious drawback to the use of molybdenum in the high temperature field does exist. It has extremely poor resistance to oxidation at elevated temperatures. Above 1,400 F the oxide evaporates leaving the metal exposed to continuous oxidation. Much research is being conducted on metal and ceramic surface coatings for molybdenum to prevent the formation of this oxide and Fansteel Metallurgical Corporation has developed a high temperature coating.

Molybdenum is used extensively in the electrical industry because of its good thermal conductivity and its high hot hardness. Applications include lamp and electron tube components, heating elements for electric furnaces, spot welding tips, electrical contacts and thermocouple protection tubes. It has replaced tungsten in many of these applications.

The use of molybdenum as an alloying element in steel is widespread because of its beneficial effects on hardenability and toughness. Here also it is being considered as a substitute for tungsten.

Prospective applications of molybdenum include die materials for die-casting brass and other high melting alloys; gas turbine and rocket components, especially sheet parts; metal working tools; piping and valves in the chemical industry.

CLADMETALS

Metal cladding is an effective method of conserving critically short or expensive material and for obtaining unique properties, especially in high temperature applications.

Cladding of metals consists of rolling sheets of different metals on each other to effect a cold welded bond. The process is used to advantage to gain corrosion resistance, heat conductivity or electrical conductivity of certain metals without resorting to the expense of using the solid material. A copper clad or silver clad steel, for instance uses only a small amount of the metal necessary for surface conductivity or corrosion resistance. In many structural applications the steel enhances the strength of the part.

A recently developed European process applies the principle of metal cladding to facilitate the chromium or silver plating of aluminum. A thin copper sheet is rolled on one or both sides of an aluminum sheet. The copper is subsequently plated with chromium or silver.

Carbon steel sheet clad with stainless steel offers considerable saving of the latter material, for applications requiring resistance to corrosion and high temperature oxidation.

In the field of high temperature alloys the American Cladmetals Company's "Rosslyn Metal" has interesting properties. This material consists of a copper core, metallurgically bonded on both sides to stainless steel or Inconel. The copper core imparts high heat conductivity throughout the sheet. The greater thermal conductivity effectively reduces buckling, warping and cracking.

SYNTHETIC RUBBER

Synthetic rubber production is being increased. This, plus the hoped-for end of government stockpiling could end the shortage. Some relaxation has already occurred, such as the recent government permission for the return of spare tires on new cars. More can be expected.

The synthetic rubbers include Buna S (butadiene-styrene), Butyl, Neoprene, Buna N (butadiene-acrylonitrile), and Thiokol. In general the synthetics have better oil and heat resistance than natural rubber but are inferior in resilience and in resistance to cold flow and permanent set. The latter two properties are of prime importance for gasketing applications.

Recent developments in the synthetic rubber field have advanced their industrial usefulness. "Cold rubber", which is Buna S copolymerized at a low temperature, usually 41F, is reputedly superior to natural rubber in abrasion resistance.

A new type general purpose neoprene was developed in 1949 by Du Pont. It has shown marked improvement in permanent set and cold flow properties, particularly at elevated temperature. Neoprene is therefore used for seals, gaskets and engine mounts where good oil resistance is an added requirement.

Neoprene "cold cure" protective coatings have been developed for such applications as pump impellers, valves and condenser heads. These coatings cure at room temperature.

New synthetic rubber adhesives for metal-to-metal bonding are competing with the resin adhesives and mechanical fastening procedures.

Closed cell rubber sponge is being used for non-absorbent gaskets and shock absorbers. Other potential uses include sound and vibration absorbers, thermal insulation and shoe soles.

There are few applications for which rubber could replace other materials. Its use as a protective coating will help conserve metal by prolonging the life of the part. Hard rubber can replace metal for small bushings subject to light loads. It is doubtful, however, whether rubber is at present more available than metal.

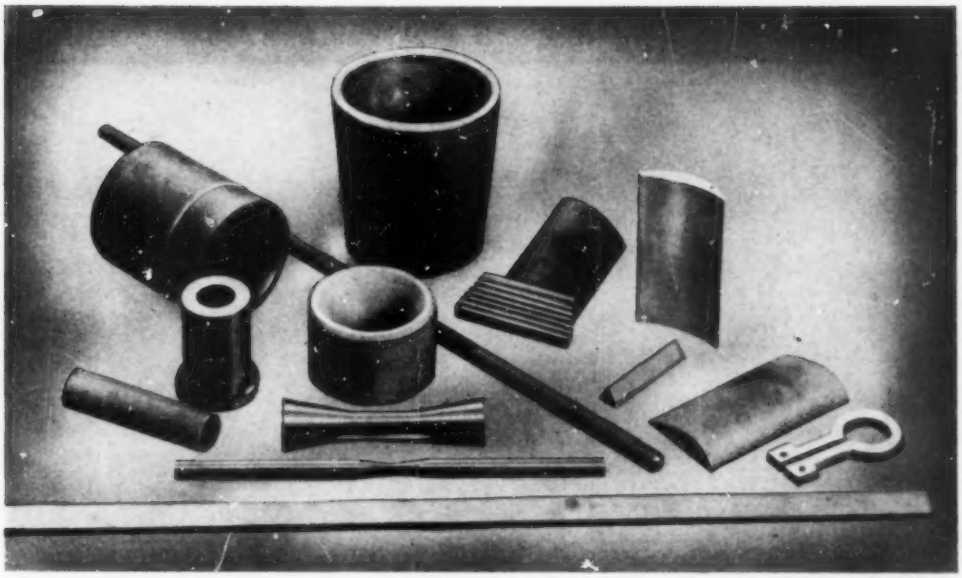
The silicones are specialized materials and cannot be considered in the substitution field. The high price of these materials would normally preclude their use except where functionally necessary. A knowledge of the properties of the silicones will not solve the materials problem but it might help expand product applications.

Silicone Fluid resists heat and cold and exhibits only a slight change in viscosity over a wide temperature range. It is effectively used as a damping fluid to reduce vibration in internal combustion engines. As a lubricant it finds application in aircraft gun charging motors which must function at very low temperatures and in delicate instruments where readings would be affected by a lubricant sensitive to temperature changes.

The liquid silicones are also used as mold releases for plastic, rubber and metal dies casting molds; as foam suppressing agents in the processing industries; as waterproof fluids; and in various waxes and polishes.

Silicone Rubber retains its flexibility and resiliency below —100F and as high as 500F. Its former brittleness has been successfully overcome and it now is widely used for gaskets, "O" Rings and seals which are subjected to high or low temperatures. The chemical inertness and non-sticking property of silicone rubber are additional advantages.

Silicone Molding Compounds are good dielectric materials because of their high arc resistance.



Eaton Metal, Inc.

Metal Refractory Alloys

The development of metal-ceramic alloys has widened the field of high temperature materials . . . but has introduced new problems of fabrication and design.

W. G. LIDMAN and H. J. HAMJIAN
National Advisory Committee for Aeronautics

METAL-REFRACTORY ALLOYS are new engineering materials that have—potentially—a large field of usefulness, not only because they make possible conservation of critical metals, but also because they have superior high temperature characteristics. Although much research and development is still required to produce a metal-refractory alloy that will be the answer to all applications, there are numerous materials that are satisfactory for specialized purposes. For example, the severe operating conditions encountered in gas turbines, rockets and other high temperature power plants require a material with the following characteristics:

1. High creep strength
2. Resistance to fracture by thermal and mechanical shock
3. Resistance to oxidation and corrosion
4. High strength to weight ratio for rotating parts

The high temperature alloys currently in operation for these applications are limited in general to operating temperatures below 1,500 F and contain considerable amounts of columbium and cobalt, now in critical supply. Increased operating temperatures are desired because of the accompanying improvements in performance. New materials containing lesser amounts of critical elements are necessary to perform satisfactorily at these higher temperatures. Certain ceramic materials fulfill these requirements because of their high melting points and low densities.

The ceramic materials that have been used in metal-refractory combinations include the oxides, nitrides, carbides and borides of metals, such as Al_2O_3, TiN, TiC and CrB. Aluminum oxide-iron compositions were first prepared in Germany during the war and were intended as substitute materials for high temperature alloys. The addition of iron caused a decrease in the elevated temperature strength and oxidation resistance compared to the pure alumina. An increase in thermal shock resistance was observed. These results indicated that the addition of iron to alumina resulted in a composite material which retains somewhat the elevated temperature strength of the ceramic and the thermal shock resistance of the metal. The tensile strength of this material at 2,200 F is approximately 10,000 psi. Results

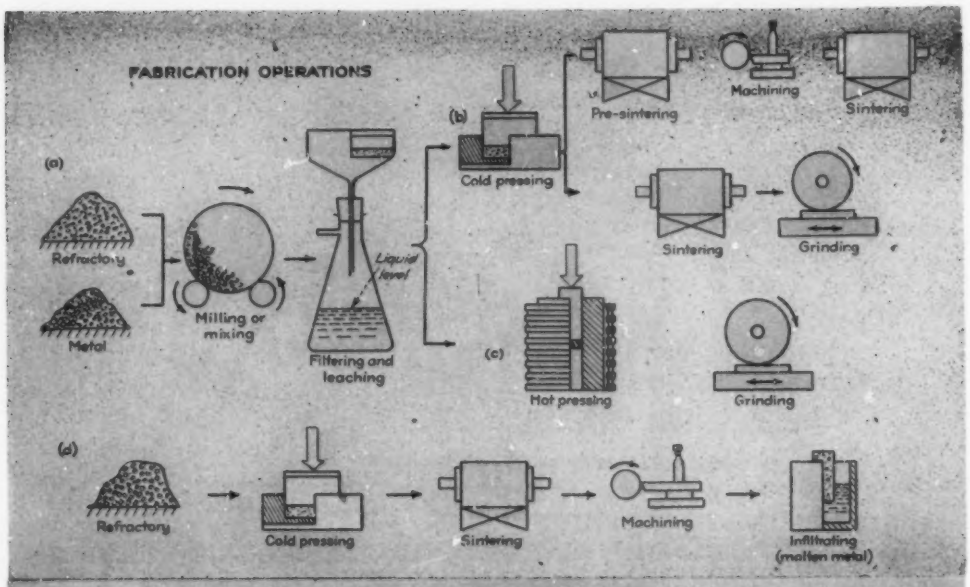


Fig. 2—Metal-ceramic alloy fabrication. (a) Powder Preparation—Fine ceramic and metal powder particles (–325 mesh) are obtained by grinding or pulverizing. These are then mixed to the desired alloy composition and blended in a ball mill to coat each ceramic particle with a continuous layer of metal.

(b) Cold Pressing & Sintering—Alloy compositions are pressed at pressures of 5 to 50 tons per sq. in. in hardened steel dies. Both hydraulic and mechanical presses are used. Sintering is done in electrical resistance or high frequency induction type furnaces in a protective atmosphere at temperatures from 2,500 F to 4,000 F. Where considerable machining is necessary a presintering treatment is used prior to machining. Final dimensions are obtained by grinding.

For the manufacture of tubes and rods of uniform cross section but too long to be handled by the conventional cold press dies, compaction by extrusion is used. This consists of mixing an organic binder such as wax with the powder and forcing this paste-like mixture through dies. The binder volatilizes during sintering.

(c) Hot Pressing. This method is utilized to produce uniform density and low porosity. Two common procedures are used: (1) apply full load at room temperature, heat to sintering temperature, release pressure, and cool; (2) apply full pressure almost immediately after powder has reached the sintering temperature. A modified process consists of applying full load at room temperature, heating to sintering temperature, maintaining load and temperature for a specified time, removing load, and cooling.

Sintering temperatures are in the same range as those used in the cold pressing method, 2,500 F to 4,000 F. Pressures are much lower, usually 500 to 2500 psi.

Graphite is used as the die material. Heat is applied to the die by an induction coil.

(d) Infiltration—This process consists of sintering the ceramic powder to a porous mass and then subsequently infiltrating it with molten metal by capillary action. This process is desirable for materials having widely different melting points and those which do not react or dissolve in one another to an appreciable extent.

of a recent investigation by Ohio State University indicate that a composition containing 70 percent alumina and 30 percent chromium by weight shows more promise than the alumina-iron compositions.

However, the disadvantage of oxide metal combinations is, in general, that they are extremely brittle. While in many applications, this brittleness could be tolerated, especially in view of the good creep strength characteristics and high oxidation resistance of oxide-metal combinations, in other cases it could not. This led to the development of alloys of metals with carbides, borides, or nitrides. These metal-ceramic alloys are commonly referred to as ceramals, cermets, metamics and cemented carbides.

Properties of Metal Refractory Alloys

There are, at present, metal refractory alloys available and a summation of the properties of those that can be discussed follows:

Alumina-chromium. A series of metal-ceramic materials (Metamics) are now being developed by the Haynes Stellite Division, Union Carbide and Carbon Corporation, which contain greater quantities of metal than of the ceramic. One of these Metamics has been designated as *LT*-1 and consists of 70 percent chromium and 30 percent alumina. The tensile strength of this material is 17,500 psi at 1,800 F, and decreases to 3,410 psi at 2,400 F. Short exposures to oxidizing conditions at temperatures up to 2,400 F showed a formation of an adherent, uniform, bright green oxide film.

This material is available in sizes up to 2 inches in diameter by 18 inches long. Rods and tubes can be fabricated with a length to diameter ratio up to 30. Metamic *LT*-1 can be machined readily with tungsten carbide

tools. The same procedures used for grinding high-speed steel can be followed when grinding is required.

Boride-metals. A study of chromium boride sintered with nickel, nickel copper, nickel chromium and cobalt was conducted by the Electro Metal Corporation. Modulus of rupture evaluation showed that the chromium boride 15 percent nickel combination was the best material investigated with a strength at room temperature of 123,000 psi. Stress rupture tests were carried out at 1,500 and 1,600 F for a 100 hour life, with stresses of approximately 4,500 and 2,500 psi, respectively. Oxidation tests at 1,900 F revealed a liquid phase formation. This formation limits the use of this material to temperatures below 1,750 F and it is possible that the presence of this low melting phase influenced the stress rupture strengths observed at 1,500 and 1,600 F. Investigation is being continued of other similar materials in which the formation of less refractory borides during exposure to elevated temperatures will not exist.

Carbide-metals. A group of titanium carbide base alloys have been investigated by Kennametal Inc. to satisfactorily meet various conditions of application. These have been termed Kentanium. Of the materials evaluated, the highest modulus of rupture and strength at room temperature and 1,800 F were obtained with a composition of 20 percent cobalt and 80 percent titanium carbide. It was also observed that the resistance of this grade (*K*-138) to oxidation could be markedly improved with minor additions of tantalum carbide or of columbium carbide and tantalum carbide in the form of a three carbide solid solution. This improvement ranged up to 40 times in some instances and is attributed to the formation of an adherent, continuous oxide film which prevents further oxidation. Other compositions developed contain nickel or iron and titanium carbide.

An investigation conducted at the NACA on other titanium carbide base ceramals containing tungsten and molybdenum indicated that the use of these more refractory metals resulted in higher strengths at 2,400 F. Oxides of the metallic constituents were found in the oxide layers formed during exposure, indicating that the oxidation characteristics of ceramals are dependent somewhat on the metal addition.

Small turbine blades made of Kentanium (grade *K* 138) have been operated under conditions simulating those in a gas turbine. Preliminary results show that these materials are promising as gas turbine blade materials for service above 1,500 F.

Research programs have been conducted at the NACA with other carbide base ceramals. A boron carbide-iron ceramal with a composition of 64 percent boron carbide and 36 percent iron by weight was fabricated by cold pressing and sintering. Although the room temperature modulus of rupture of this material was not high (39,100 psi) a high percentage of strength was retained at temperatures up to 2,600 F (23,400 psi). The outstanding characteristic of this material is its low density (3.24 gm/ml) which makes it of interest for use in rotating parts where stress is proportional to rotating speed and density. The strength density of this material at 2,400 F, compared with other promising ceramals is shown in Table III. Results of oxidation tests showed that the ceramal oxidized rapidly at 2,000 F, probably as a result of a reaction between the boron and iron oxides that are formed. The oxidation products sublimed at a rapid rate and resulted in a loss in weight. A protective coating would be required for this material to permit continued operation above 1,600 F.

Zirconium carbide—columbium ce-

Table I—Properties of Superalloy-Infiltrated Titanium Carbide Composite Materials Suitable for High Temperature Service

Refractory Component	Superalloy Component	Modulus of Transverse Rupture, psi		Maximum Deflection Under Maximum Load at 1800 F., inches	Oxidation Resistance—Weight Gain After 100 Hours Exposure to Still Air at 1800 F., *mg/cm²/hr.
		At Room Temperature	At 1800 F.		
Titanium Carbide	Vitallium	62,000 196,000	81,000 144,000	0.028-0.380	0.0485-0.0925
Titanium Base Double Carbide	Vitallium	63,000 131,000	102,000 114,000	0.029-0.065	0.0713-0.0831
Titanium Carbide	Nichrome	80,000 216,000	43,000 83,000	0.060-0.238	0.0705-0.0713
Titanium Base Double Carbide	Nichrome	135,000 230,000	86,000 117,000	0.217-0.236	0.0780-0.0880
Titanium Base Double Carbide	Inconel	145,000	74,000	0.142-0.221	0.0624-0.0675
Titanium Carbide	Stainless Steel Type310	53,000 124,000	52,000 87,000	0.024-0.066	(0.2080-0.3466)"
Titanium Carbide	Stainless Steel Type 403	53,000 106,000	67,000 87,000	0.016-0.040	(0.6733-0.6740)"
Titanium Base Double Carbide	Stainless Steel Type 310	90,000 128,000	93,000 124,000	0.040-0.086	(0.1070-0.2965)"
Titanium Base Double Carbide	Stainless Steel Type 430	143,000 196,000	91,000 93,000	0.200-0.248	(0.3265-0.1283)"

* Specimens withdrawn from test furnace, cooled, weighed, and reheated after each 20 hours (total of 5 cycles). "Figures inaccurate due to spalling and chipping off of surface scale formed.

Materials Corporation of America

Table II—Modulus of Rupture Strength of Ceramals Evaluated at NACA

Fabrication method	Composition		Density gr/ml.	Modulus of Rupture, psi			
	Refractory (%)	Metal (%)		1600F	2000F	2400F	2600F
Cold Pressed and Sintered	95 TiC	5 Co	5.08	56,800	44,100	2,900	.....
	90 TiC	10 Co	5.19	73,400	39,900	2,000	.....
	80 TiC	20 Co	5.38	100,800	71,900	2,400	.....
	70 TiC	30 Co	5.54	99,300	65,400	2,400	.....
	95 TiC	5 W	5.19	62,900	37,700	9,100	.....
	90 TiC	10 W	5.08	51,600	32,800	19,000	.....
	80 TiC	20 W	5.36	33,700	22,900	11,000	.....
	70 TiC	30 W	5.88	29,700	18,500	9,700	.....
	95 TiC	5 Mo	5.17	44,100	41,400	10,500	.....
	90 TiC	10 Mo	5.10	53,000	42,000	20,900	.....
	80 TiC	20 Mo	5.27	33,900	30,100	17,200	.....
	70 TiC	30 Mo	5.74	51,200	46,500	4,400	.....
	64 B_4C*	36 Fe	3.24	32,600	32,000	28,600	23,400
Hot Pressed	87.5 ZrC*	12.5 Cb	6.29	.....	25,200	15,900	.....

* Fabricated at NACA.

Table III—Properties at Elevated Temperatures

(a) Tensile Strength

Commercial Designation	Composition		Tensile Strength, psi	
	Refractory (%)	Metal (%)	1800 F	2200 F
LT-1	30 Al_2O_3	70 Cr	17,500	6,630
K139	95 TiC	5 Co	22,600	9,800
K140	90 TiC	10 Co	24,600	14,400
K138	80 TiC	20 Co	34,600	13,200
K141	70 TiC	30 Co	22,600	14,700
Commercial High Temp. Alloy			33,000	.....

(b) Modulus of Rupture Strength—Density Ratio

Commercial Designation	Composition		Density gr/ml.	Modulus of Rupture Strength—Density Ratio		
	Refractory (%)	Metal (%)		1600 F	1800 F	2400 F
K138	80 TiC	20 Co	5.35	13,700	20,600	449
	95 TiC	5 W	5.19	12,100	.....	1750
	90 TiC	10 W	5.05	10,150	.....	3762
	90 TiC	10 Mo	5.12	10,400	.....	4082
	64 B_4C	36 Fe	3.26	10,050	.....	8773
	87.5 ZrC	12.5 Cb	6.29	.....	.....	2500
LT-1	30 Al_2O_3	70 Cr	6.0	.....	6,340	2500a
K151	80 TiC	20 Ni	5.45	.....	16,700	.....
K139	95 TiC	5 Co	5.09	11,150	.....	570

a Evaluation temp. 2552 F.

ramals were fabricated by the modification of the hot press method. Properties of an 87.5 percent zirconium carbide and 12.5 percent columbium alloy are listed in Tables II and III b.

Titanium carbide composite materials for high temperature use have been fabricated by the infiltration method by the Sintercast Corporation of America. These materials consist of titanium carbide or titanium carbide base double carbide skeleton infiltrated with a number of current high temperature alloys. Materials investigated have good strength properties up to 1,800 F, and there are indications of some ductility at 1,800 F, which is of considerable importance from a design standpoint.

Design and Fabrication

Due to the high melting temperatures of all of these materials, fabrication of parts is presently limited to powder metallurgical processes. These include cold pressing and sintering, hot pressing, and infiltration. In Fig. 2 is shown a graphical description of these processes.

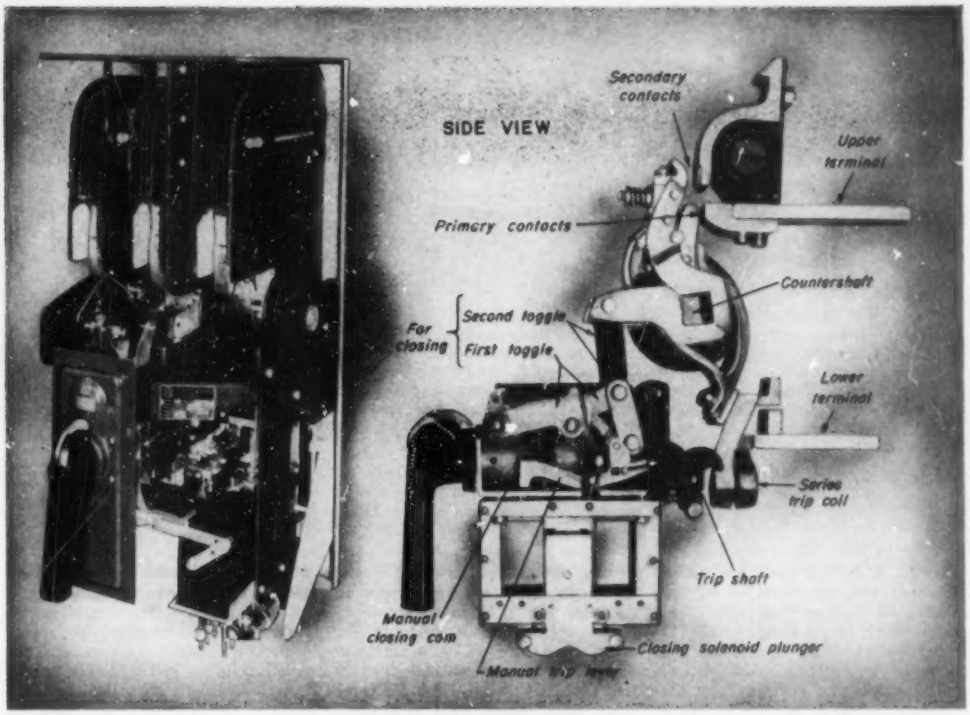
There are many problems that must be overcome before metal-ceramic alloys can be used successfully and economically. One problem is the brittle nature of these materials at room temperature; it is necessary that these new alloys be handled with considerably more care than present metal alloys. This low ductility also makes them susceptible to failure when exposed to rapid temperature fluctuations. The thermal conductivity of many of the better materials is higher than that of current blading materials and in the rotor turbine blades this property causes the rim of the disk to run hot, posing a new problem in the disk material.

To conform with the powder metallurgy process limitations the following features should be avoided in the design of parts: (1) Abrupt changes in thickness; (2) non-uniform cross sections; (3) sharp corners; (4) internal angles without fillets.

The extreme hardness generally obtained with ceramal combinations after sintering or infiltration necessitates rough machining or grinding of parts in the pre-sintered condition. Operations such as cutting, boring, or turning can be performed at this stage. After final sintering surfaces requiring a fine finish or close tolerances can be ground to final dimensions with diamond abrasive wheels.

A recently developed machine is reported to perform cutting, threading, drilling, and other machining operations on fully sintered carbide or boride base ceramals. Holes, openings, and recesses can be formed in diameters from 0.007 to 2 in. with tolerances of 0.002 inches. The blunt tool used is made from a material such as cold rolled steel and is formed in the shape of the impression to be made in the sintered piece. The tool oscillates against the piece at the rate of 27,000 times per second while a liquid suspension of an abrasive is flowed over the work area. The method of cutting leaves a smooth surface on the finished piece and no further finishing is necessary. For close tolerances, it is desirable to use a roughing tool and follow with a finishing tool that will produce the desired dimensions.

Fabrication techniques have to be improved and developed to a point where they are economically comparable to casting and forging techniques. Kentanium blades are now being machined on multiple-spindle contour forming machines. With such techniques some blade shapes may soon compare favorably with present metal alloy blades in cost.



Present day circuit breakers are intricate mechanisms with many linkages as shown in the side view. To under-estimate the effects of friction in the many pivots, may result in the locking or unsatisfactory operation of these devices.

Starting Friction in Mechanical Linkages

Friction in mechanisms is often neglected yet it is one factor which determines the effectiveness of many devices. Examples show the part friction plays in design.

CARL THUMIM
I-T-E-Circuit Breaker Company
Philadelphia, Pa.

STARTING FRICTION COEFFICIENTS of linkage connections are large, approaching a value of 0.25 with metal to metal bearings. This holds true where one of the metals has a heterogeneous structure to supply microscopic pockets for lubricant which prevents scoring or galling. For example steel shafts run well in bearings made of bronze, cast iron or babbitt but will wear rapidly in bearings made of homogeneous metal such as brass, steel or silicon bronze.

Since the exact condition of lubrication in these mechanisms is not known, the design must be proportioned to insure proper functioning over a wide range of conditions from full lubrication to boundary lubrication; the coefficient of friction may vary anywhere between zero and 0.25. It is not often recognized that a coefficient with a value of zero may apply under conditions of vibration.

Friction Forces on Links

In analyzing friction forces on two parts rotatably connected by a pin, the pin may be considered fixed to one of the parts using the other part as a

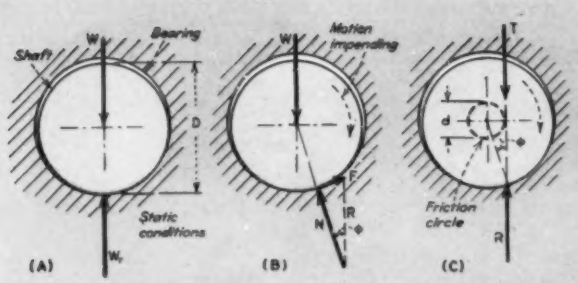


Fig. 1—When a shaft rests in a bearing, the weight W and reaction W_r coincide (*A*). In (*B*) rotating the shaft causes the point of contact to move and alters the normal force N due to the friction force F. (C) Extending a line through R determines the size of the friction circle: $d = Df$.

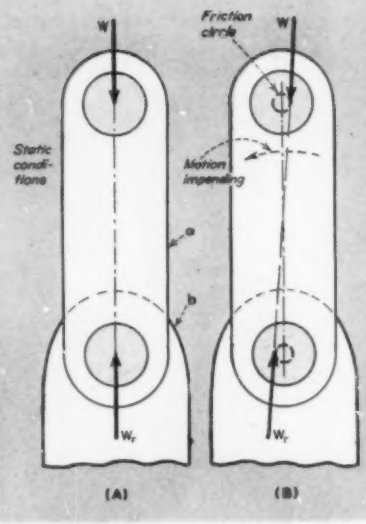


Fig. 2—Diagrams of simple links illustrates how the line of action is affected by: the friction on the pins, the direction of impending motion and the direction of applied force.

bearing. A definite assumption must be made and the direction of the forces and rotation established. No matter which part is assumed to act as a bearing, the final results are the same.

To analyze the friction in a pin connection, Fig. 1 is used. A shaft carries a load W and rests on the bottom of the bearing, there is a reaction force W_r against the shaft when it is stationary, see Fig. 1(A).

When the shaft is rotated it tends to climb up on the bearing until an equilibrium condition is reached where the reaction force N and the friction force F causing the climbing action is balanced. Shown in Fig. 1(C), the resultant of these two forces is R and at angle ϕ to N. If R is extended beyond the center of the shaft, it will be approximately tangent to a friction circle diameter, $d = fD$. To balance R, an equal force T is applied in line but opposite to R. This force T is tangent to the friction circle and is the resultant of both W and the force causing the turning effort.

The direction of climb of the shaft in starting or slow motion should not be confused with its position when running fast enough to establish a continuous oil film. Here the wedge-shaped contour of the clearance, drags in oil and places it under pressure sufficient to lift the shaft and push it toward the opposite side. This running shaft reaches equilibrium off-center on the side opposite to the side that it climbs under conditions of boundary or poor lubrication.

In Fig. 2(A), when link a is stationary, the compression load W and its reaction W_r oppose each other on the center line. Rotating link counter-clockwise, the line of action of the compression load W will shift and be tangent at the left of the lower friction circle. See Fig. 2(B). Here the lower pin is considered to be fixed to link a and rolling in bearing b. The upper pin will rotate clockwise in respect to the link, and the line of action of the force will be tangent at the right side of the friction circle.

When link a, in Fig. 2 (C), rotates in a clockwise direction, the line of action of the compression forces will then be tangent to the left of the upper and

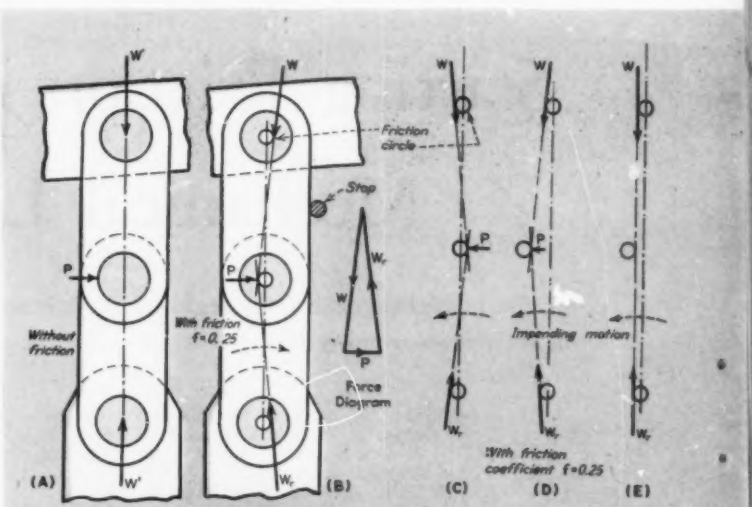
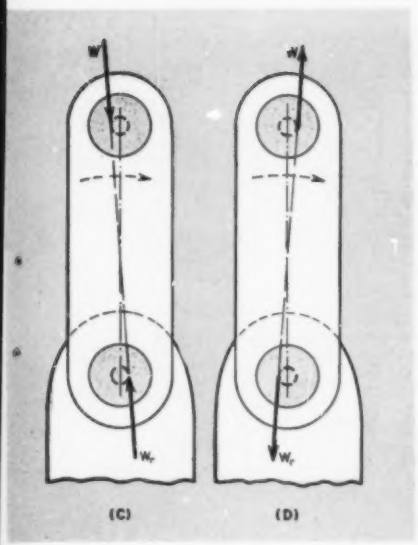


Fig. 3—Toggle linkages: (A) Neglecting friction. P exerts an infinite force. (B) With friction, P exerts a force of definite magnitude W and W_r shown in the force diagram. In (C) linkage is locked by friction; (D) position of linkage to easily collapse toggle; (E) linkage is shown on friction dead-center.



to the right of the lower friction circles. If the link rotates in the same direction as in (C) but the forces are reversed and become tensile forces, the line of action is in the same direction as that of Fig. 2(B). If both direction of rotation and direction of forces are reversed, the line of action of the forces remains the same.

Toggle Friction

Toggles are among the most commonly used devices for two reasons. One is to greatly amplify forces; the other is to act as a lock against a large force and to permit unlatching with a small force. When the two links composing a toggle have their pins in a straight line as shown in Fig. 3(A), the applied force P will exert an infinite force W'P only if friction is neglected. However, with friction the force diagram will change as in Fig. 3(B), and the force W is found to be still quite appreciable as shown in the diagram. The unlatching force required to move this linkage from the dead center position should be zero but Fig. 3(C) shows that the toggle is locked over center by friction. To get the toggle to collapse, the pins should be beyond the center by at least the amount required to offset the friction effects by having a horizontal component of the friction forces toward the left as shown in Fig. 3(D). When the forces are in line, as in Fig. 3(E), the toggle is locked on friction dead center.

Friction in Levers

Analysis of the friction in a lever is shown in Fig. 4: (A) illustrates the static position, (B) shows the weight W moving the lever clockwise against a restraining force P, in (C) force P is turning the lever counter-clockwise and lifting the weight W. The equations give the relationship of the force required to cause motion which is always greater than the force moved. In these figures, the coefficient of friction f is 0.25. It should be noted that the friction losses cannot be estimated by blanket values equal to the coefficient of friction but depend on the proportions of the device. In example (B), if x and y are 3 in. and D is 1 in., the restraining force P equals $0.85W$. With a lever arm of 10 in., then $P = 0.95W$.

Force Reduction Lever is shown in Fig. 5(A) where a large force W is restrained by a latch and lever which are so proportioned that a small force L is required for release. In the vector diagram Fig. 5(B), the solid lines indicate the condition neglecting friction; the dash lines show the forces with friction. The force P which has to be released by L is much larger without friction than it is with friction. This example emphasizes that the forces at both extreme conditions (with zero and maximum values of friction coefficients) must be checked and provisions made for proper operation under all values within the range. If the line of action of W' is tangent to the friction circle of the main shaft, it would also coincide with R' and the value of P' would be zero. Under such conditions there would be no pressure on the latch

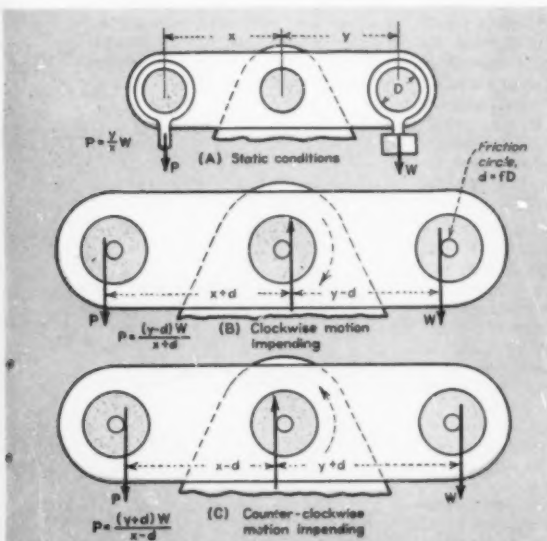


Fig. 4—Friction in levers can alter the required force for movement. From the equations given, this is particularly true for short levers on the large-size pins.

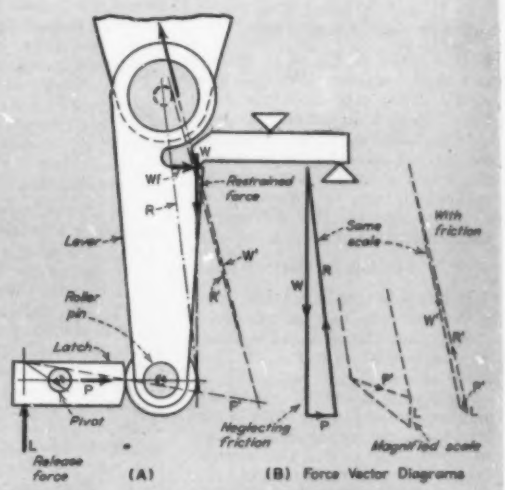


Fig. 5—In this force-reduction lever, neglecting friction shows that the latch pressure P is high. Actually with friction, this force P' is very small.

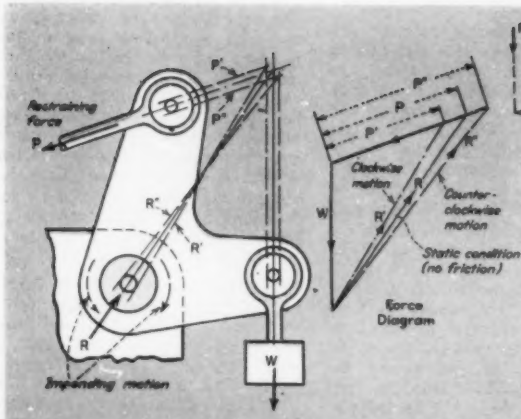


Fig. 6—Analysis of a bell crank illustrates how the effects of friction and the direction of rotation alter the restraining force *P*.

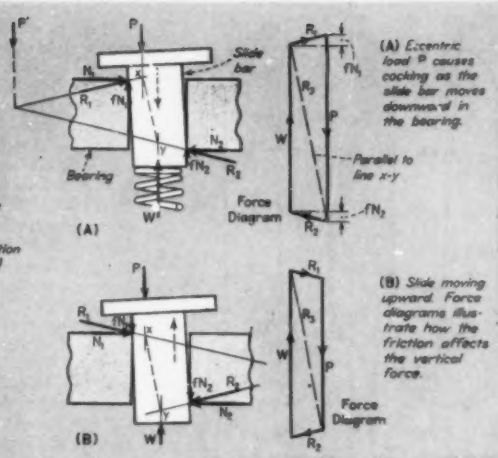

Slide bar
Bearing
(A)
Force Diagram
(A) Eccentric load P causes cocking as the slide bar moves downward in the bearing.
Parallel to line x-y
(B)
(B) Slide moving upward. Force diagrams illustrate how the friction affects the vertical force.

Fig. 7—Friction in slides.

and no torque is required to move the lever. This device would also be ineffective and move away from the latch if W' rotates further counter-clockwise or the point of load application moves toward the left.

Method of analyzing friction forces on a roller are also shown in Fig. 5(A). Force P' is drawn from the point of contact between the roller and its latch, tangent to the friction circle of the roller pin. Thus the release force L is found from the enlarged diagram in Fig. 5(B).

BELL CRANK in Fig. 6 is analyzed in a similar manner. The solid lines in the vector diagram represent the forces under static conditions. With counter-clockwise motion impending, the required applied force P'' to raise the weight is much greater than the restraining force P' necessary for clockwise motion. This difference is due to the effects of friction.

Friction in Slides

In this group are included all linear guided motions such as crossheads, pistons, cam followers and dashpots. The analysis of such friction forces are shown in Fig. 7. In (A) slide bar is moving downward in a bearing under action of force P. This motion compresses the spring which exerts an upward force W. The eccentric application of the load causes the slide to touch the bearing at two diagonally opposed edges and these points exert normal forces N_1 and N_2. Combining these forces with their friction components, give the resultants R_1 and R_2.

To solve this system of four forces P, W, R_1 and R_2, these forces are paired to obtain a common resultant for each pair. In this case, P intersects R_1 at x and force W intersects R_2 at y. Joining x and y gives a line along which a common resultant of the two pairs can be drawn. This resultant R_3 is found in the diagram. It graphically indicates that the force P (input) is greater than W (output) by the amount of the friction loss.

If the position of P were shifted toward the left to P' here it would meet the intersection of R_1 and R_2. These three forces would then be in equilibrium and the value of W would be zero. Under such conditions the slide would be stuck, an event which is not too uncommon. With upward motion, the friction forces are reversed as shown in Fig. 7(B) and the corresponding force diagram.

VALVE LIFTER shown in Fig. 8 is analyzed in a manner similar to that of Fig. 7 except that the friction drag of the cam against the follower surface is included. With this additional friction (fP), line of action is changed and it is difficult to tell by inspection which side bears against the guide wall. If a wrong assumption is made, as in (A), this will be proved by the open force diagram. The analysis should be repeated as in Fig. 8 (B) and verified by the closed diagram. In (B) note that Reactions R_1 and R_2 are in the same direction and can be represented by a single resultant $R_t = R_1 + R_2$. Thus only different three forces W, R_t and R_p are required for a complete solution.

DASHPOT FRICTION analysis parallels that of slides. However, a number of solutions should be made covering different points in the stroke. As shown in Fig. 9 the side-wall friction plays a large part in the energy absorbed. A plot of the friction values makes possible the measurement of the output of the dashpot versus the input. With the energy to be absorbed and the movement of the piston, the pressure inside the pot can be calculated, and it is a simple matter to compute the orifice size necessary to transfer the displaced liquid from the high to the low pressure side of the piston for any period of time.

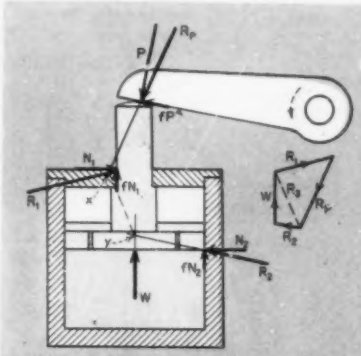


Fig. 9—Frictional forces in dash-pots should be examined over the entire stroke to insure proper operation. Diagram shows the forces at one particular position.

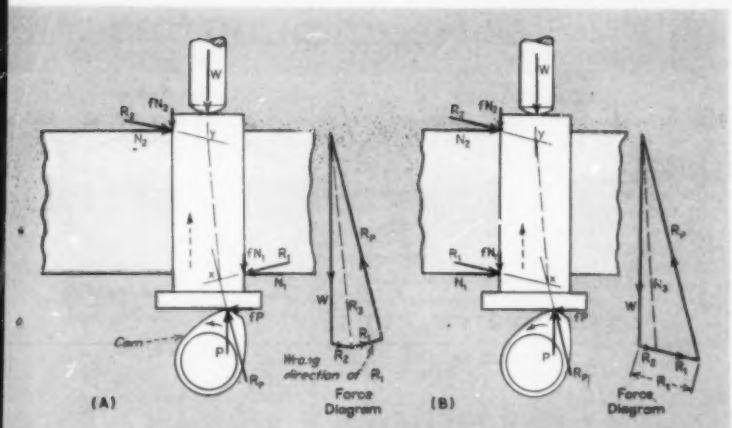


Fig. 8—Forces acting on valve lifter make it impossible to assume the frictional effects. (A) An incorrect assumption of the reaction R_1 is evident in the force diagram. (B) Proper direction of friction is verified by the force diagram.

Mechanism Analysis

By means of the elements discussed it is possible to analyze the starting and slow moving friction of any mechanism. To illustrate this, a device where fluid pressure compresses a spring is shown in Fig. 10. Two extreme positions are shown and four points have been chosen to give a picture of its operation. The locations of the center lines, friction points and friction circles are found for each of the four positions and the corresponding force diagrams are made for each case, both with and without friction. Where motions are more complex, more positions may be required.

Since the spring force S must move the piston backwards when the total fluid pressure P is removed or reduced, links BC and BD must be far enough from center to insure that friction does not cause sticking or locking. Force diagram in Fig. 10(B) proves that in position 1, with $f = 0.25$, there is a positive force AB opposing the fluid force P; when P is reduced, component AB will cause motion toward the left.

To find the relation of the forces when the spring is being compressed, four force diagrams were constructed neglecting friction. Similar diagrams were also made considering friction, $f = 0.25$. The final result is plotted in the graph of Fig. 11 which illustrates the effect of friction losses throughout the stroke. Since the fluid pressure is usually constant, these curves also show the required force of the spring at the different positions.

Thus to insure satisfactory operation, the spring force at any point must be below the lower curve. Its gradient, or spring constant may be tangent to the lower curve. For example, if a specific spring were chosen (dotted line) and the actual friction was $f = 0.25$ this device would become locked between positions 2 and 3. Since the actual value of the coefficient of friction is unknown but lies between the two curves. The selected spring should be below the lower curve, and the area between these two regions represents excess energy of the fluid piston. This excess energy must be absorbed by a buffer stop or by a fluid orifice to maintain low speeds.

This graphic method of friction analysis of mechanisms in the early stages of design adds a small amount to the total effort, especially since it can be applied directly to the layout without the necessity of making measurements of distances or angles. Yet, it may make the difference between success or failure in operation by bringing out the serious effects of friction. It has been time-tested and can easily be applied by any designer familiar with force analyses.

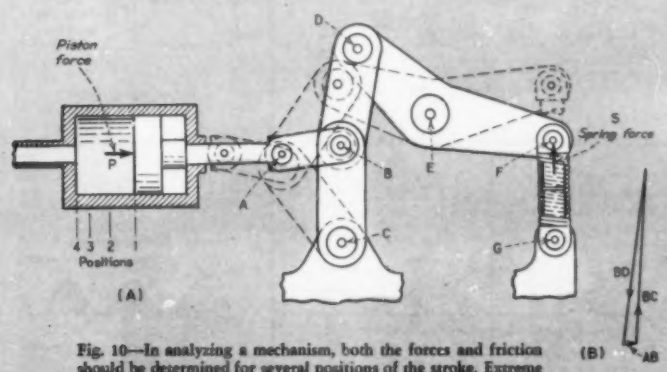


Fig. 10—In analyzing a mechanism, both the forces and friction should be determined for several positions of the stroke. Extreme positions of motion are illustrated in (A). Force diagram considering friction (B) indicates that the toggle linkage is not locked and will move when P is reduced.

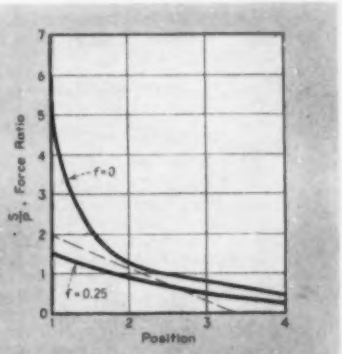
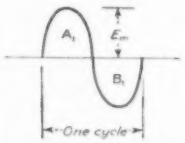
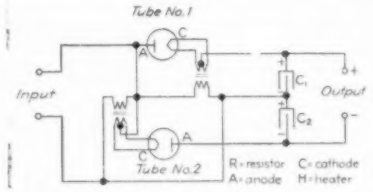
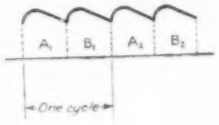
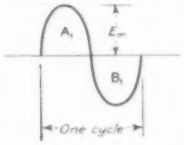
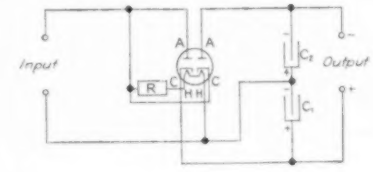
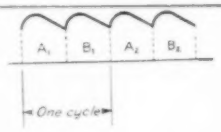
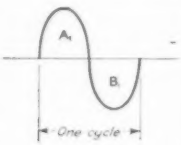
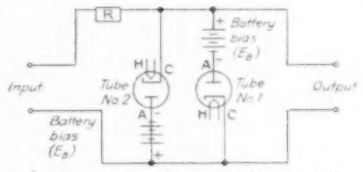
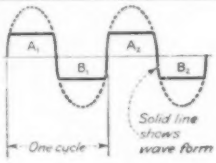
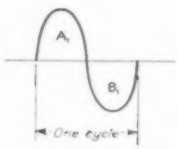
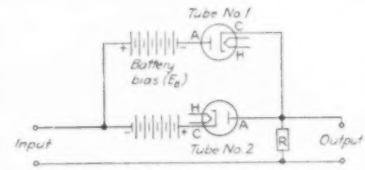
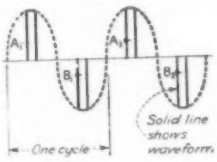
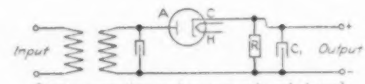
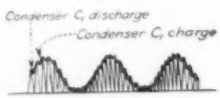


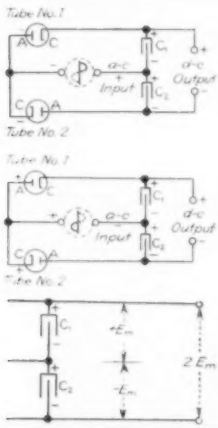
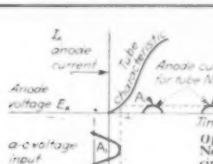
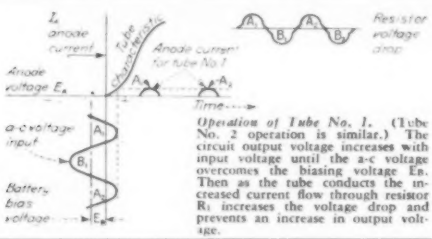
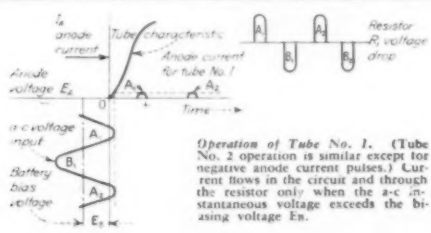
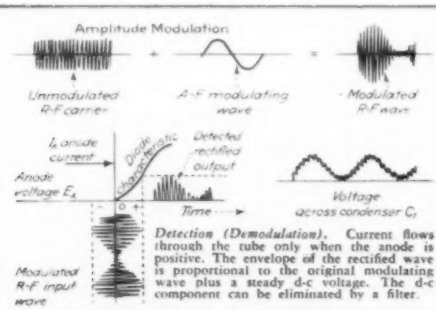
Fig. 11—Ratio of Spring to Fluid Force chart is used to select proper spring for the mechanism in Fig. 10. If spring gradient (dash line) is above the actual friction line, device will stall or become locked by friction.

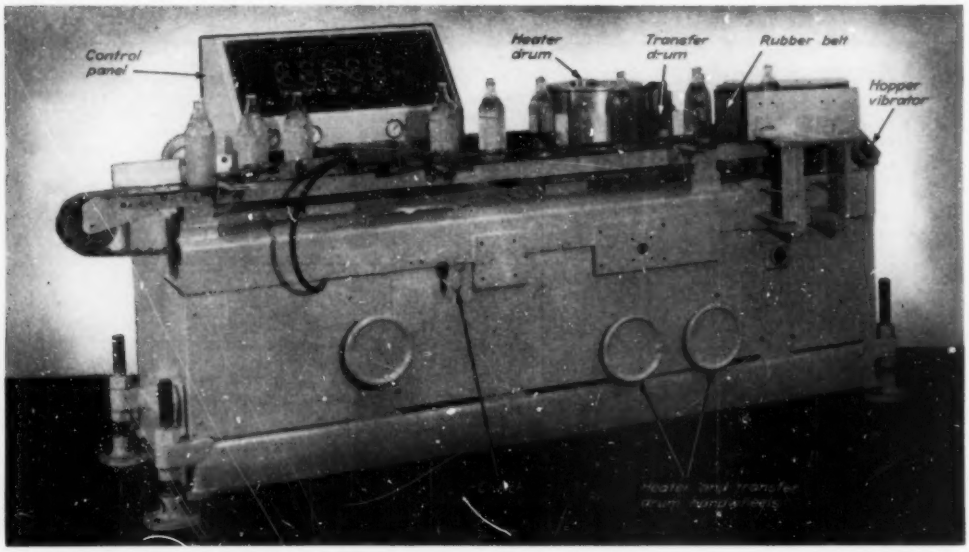
Rectification and

Type	Input Voltage	Circuit Sketch	Output Voltage
Voltage Doubling Rectifier Circuit	 f = Frequency (a-c sine wave)		 Major ripple frequency = 2f cycles (pulsating d-c)
Transformerless Voltage Doubling Rectifier Circuit	 f = Frequency (a-c sine wave)		 Major ripple frequency = 2f cycles (pulsating d-c)
Peak-Clipping Circuit (Converting sine wave to square wave)	 f = Frequency (a-c sine wave)	 (Heater connection and power supply not shown)	 Frequency = f cycles (a-c rectangular wave)
Pulse Forming Circuit (Converting sine wave to series of pulses)	 f = Frequency (a-c sine wave)	 (Heater connection and power supply not shown)	 Frequency = f cycles (a-c periodic pulse)
Diode Detector Circuit	(Modulated radio frequency wave)	 (Heater connection and power supply not shown)	 (Rectified audio-frequency wave)

Voltage Transformation

R. B. IMMEL
Westinghouse Electric Corporation

Operation	Remarks
 Tube No. 1 conducts during the positive half-cycle and a positive charge accumulates on the upper plate of condenser C_1. A positive voltage ($+E_m$) builds up across the condenser to a maximum value equal to the peak of the a-c input voltage. Tube No. 2 conducts during the negative half-cycle and a negative voltage ($-E_m$) builds up across the condenser C_2. Since the condensers do not lose their charge during a half-cycle of time, the total output voltage is twice the input a-c peak voltage for no load.	The voltage doubler circuit is a special rectifier circuit which employs two diode vacuum tubes and two capacitors so arranged that the output voltages of the half-wave rectifier tubes are connected in series. The d-c output voltage is twice the peak a-c input voltage at no load. It may be used for a high voltage d-c supply without the use of a transformer between the rectifier and the a-c supply. As the voltage regulation is poor and the tube peak currents are high, the use of the voltage doubler circuit is limited to applications which require very little power.
 This tube and circuit are frequently used in "transformerless" radio receivers.	This circuit operates the same as the previously described voltage doubler. The tube was especially designed for voltage doubler circuits and combines two diode vacuum tubes in one envelope. With the connection shown, no anode or heater transformers are required. This tube and circuit are frequently used in "transformerless" radio receivers.
 *Operation of Tube No. 1.* (Tube No. 2 operation is similar.) The circuit output voltage increases with input voltage until the a-c voltage overcomes the biasing voltage En. Then as the tube conducts the increased current flow through resistor R_1 increases the voltage drop and prevents an increase in output voltage.	A rectangular wave form can be obtained by clipping off the peaks of a sinusoidal voltage wave. Application of a rectangular voltage wave to certain capacitor-resistor circuits will produce a very sharp voltage peak wave form. This voltage pulse may be used for triggering or initiating current flow in a thyratron tube or controlling the operation of a trigger circuit. The rectangular wave form may be amplified and reclipped to obtain a more abrupt change in voltage. The fidelity of an amplifier or transformer may be checked very quickly by impressing a rectangular or square wave form on it and viewing its output with a cathode ray oscilloscope. The apparatus must reproduce the fundamental wave form and at least the 30th harmonic.
 *Operation of Tube No. 1.* (Tube No. 2 operation is similar except for negative anode current pulses.) Current flows in the circuit and through the resistor only when the a-c instantaneous voltage exceeds the biasing voltage En.	By biasing the anode circuit very high with respect to the impressed a-c peak voltage, a symmetrical voltage pulse can be obtained. The tube conducts current only at the peak of the voltage wave or when the a-c voltage exceeds the biasing d-c voltage. The voltage drop across the resistor provides the output voltage. The duration of the pulses can be decreased by amplifying them and then impressing them on a similar pulse forming circuit. The pulse may be used for triggering or initiating operation of certain circuits and apparatus.
 *Detection (Demodulation).* Current flows through the tube only when the anode is positive. The envelope of the rectified wave is proportional to the original modulating wave plus a steady d-c voltage. The d-c component can be eliminated by a filter.	In radio and carrier-current communication a R-F (Radio-Frequency) wave is used as a carrier because it can be radiated. In transmission of speech or signals, the carrier must be modulated or varied in amplitude by an A-F (Audio-Frequency) wave. The detector in a radio receiver separates from the R-F wave, a wave form which is proportional to the original A-F signal and which will approximately reproduce the original sound in the speaker. When the rectified current flows through the resistor, the condenser C_1 is charged to the peak voltage of the modulated signal. When the tube is not conducting and when the signal has a negative value, the condenser discharges through the resistor to a value slightly lower than its original charging voltage. When the positive R-F voltage exceeds the condenser voltage, the tube will conduct and recharge the condenser. The envelope or contour of the output wave is proportional to the original sound wave or signal.

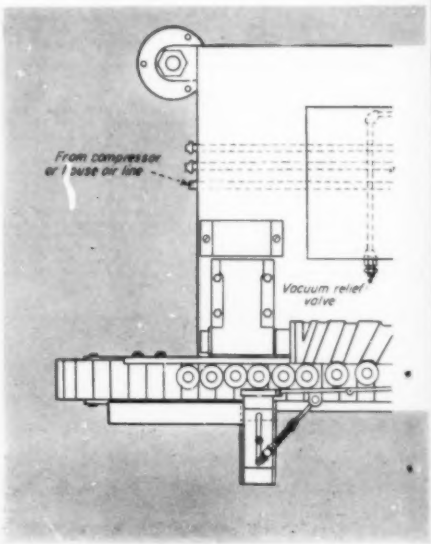


BOTTLES ARE TRANSPORTED by a table top conveyor chain to the feed screw which spaces them with relation to the labels on the heater drum. Heater and transfer drum handwheels adjust the vertical position of the labels to accommodate different size bottles. Label hopper is attached to the transfer drum and moves vertically with it, eliminating a separate adjustment. Side guides of the conveyor system are adjustable by means of three Allen screws.

High Speed Machine Blows Labels on Bottles

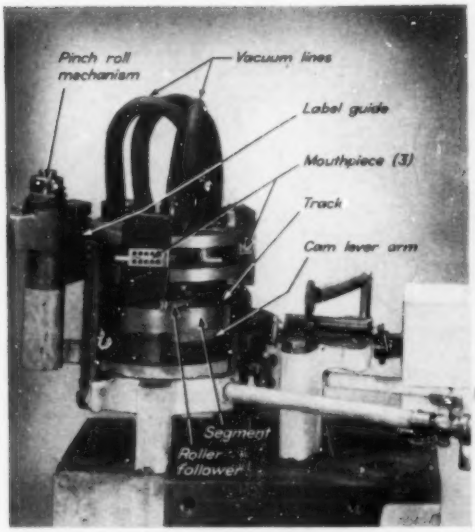
Speed plus flexibility in bottle labeling is achieved by the Model 160 Label DRI, designed and manufactured by the New Jersey Machine Corporation of Hoboken, N. J. By using a continuously-rotating heated drum that alternately employs suction and a blast of air to hold and deposit labels on bottles respectively, as many as 400 labels per min can be applied. No glue is needed. The labels are already coated with a thermoplastic material which becomes tacky when heat is applied. Bottles move through the machine in a continuous stream without physical contact with the machine until they pass through a soft rubber belt which rolls the entire label tightly to the bottle.

The conveyor system and all labeling components are readily adjustable for labels from $\frac{1}{2}$ x $1\frac{1}{4}$ in. through 4 x 5 in. which covers bottles ranging from about 2 cc's to one quart. The only machine component which must be replaced to cover this range of bottles is the laminated phenolic feed screw, and since one screw can handle several sizes of bottles, five screws will normally handle this complete range of sizes.

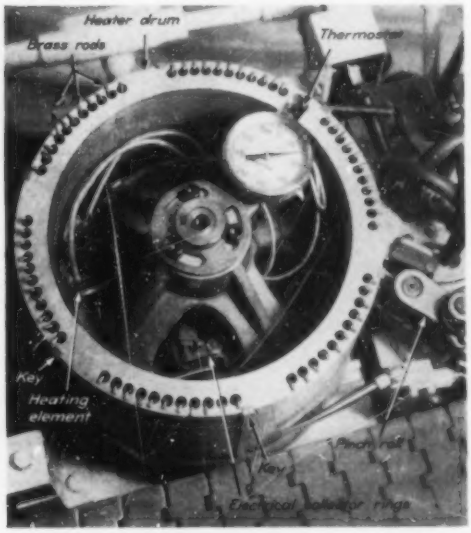


LABELS ARE REMOVED from the electrically vibrated hopper by a suction mouthpiece in the transfer drum, held by a pinch roll and then are trans-

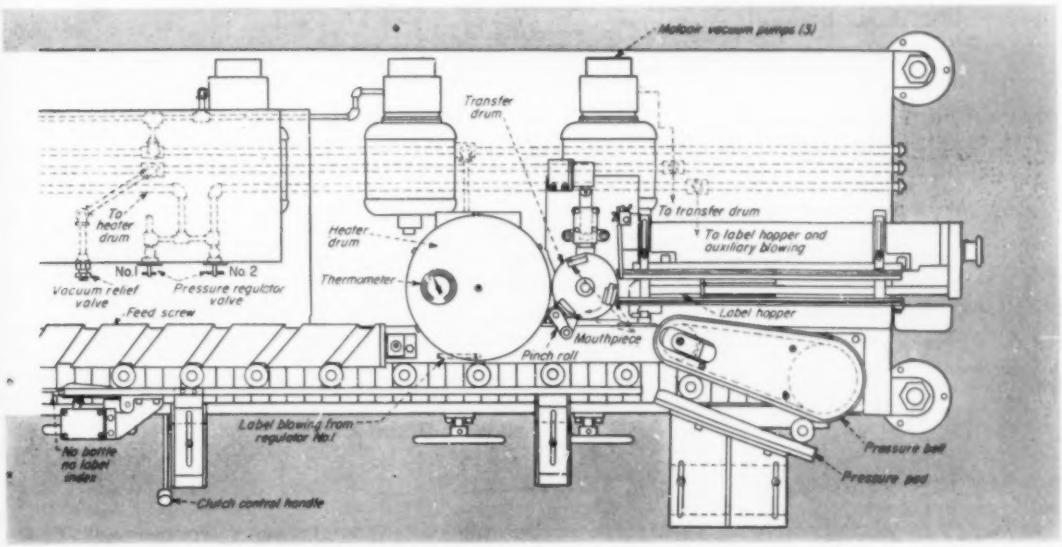
IN NEW PRODUCTS



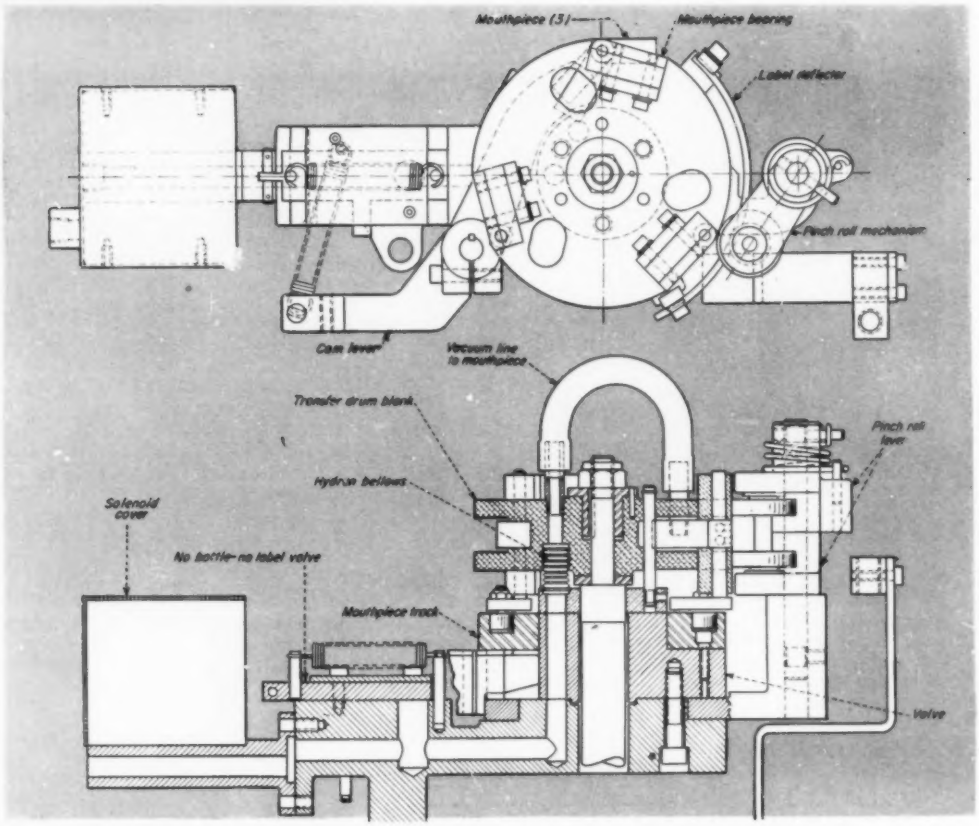
ROLLER FOLLOWER MOVING in track pivots mouthpieces to pick-up labels from the hopper when cam lever arm displaces track segment radially inward as shown. After receiving labels, mouthpieces return flush with drum.



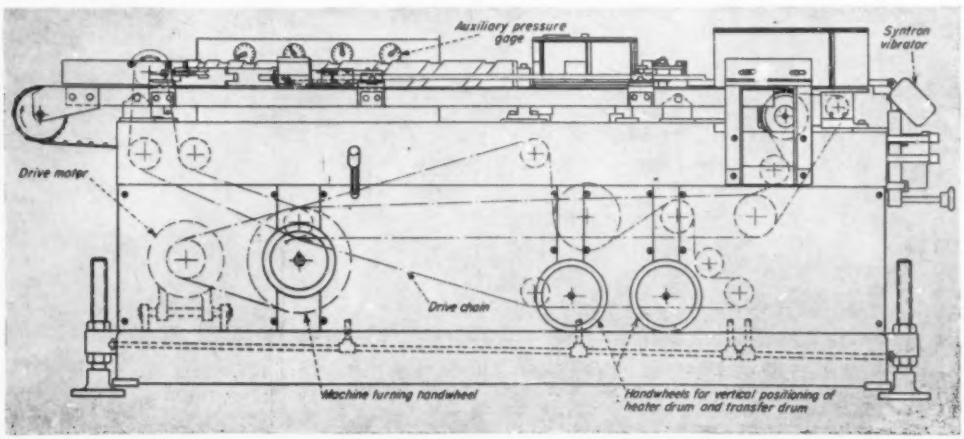
AS LABEL APPROACHES HEATER DRUM, suction is cut off and label is held by pinch roll. Roll releases trailing edge of label after leading edge is buckled against key on heater drum. Buckling assures proper label register.

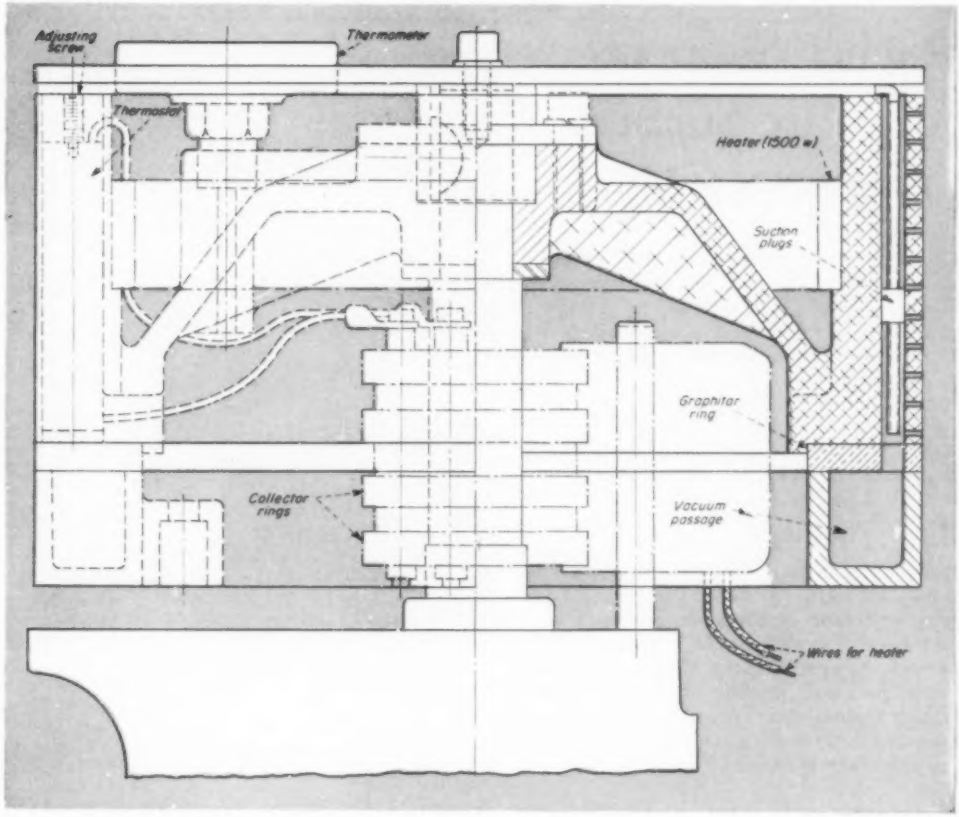


ferred to the heater drum where they are held by suction. Thermostatically controlled heating elements in the drum keep temperature such that thermoplastic coating becomes sticky. As label on heater drum approaches a bottle, a porting arrangement progressively cuts off the vacuum starting at the leading edge of the label and, while the trailing edge is still held by suction, a blast of air blows leading edge of label on the bottle.

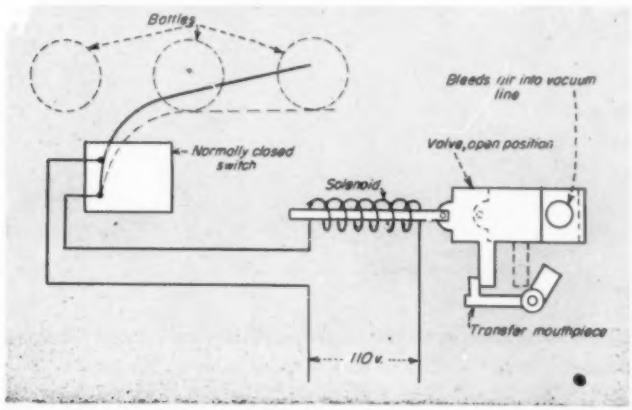


TRANSFER CYLINDER is the only machine element which has intermittent motion. It stops every 120 deg to allow the mouthpieces to pick-up labels. A cylindrical indexing cam with three roller followers accurately accelerates and decelerates the cylinder to keep it in precise register with the heater drum which is rotating at constant speed.





BY MEANS OF A PORTING ARRANGEMENT between the continuously rotating heater drum and its stationary base, the same row of holes which applies suction to retain labels is used to transmit air under pressure to force the leading edge of the label on the bottle. Suction area of the drum is adjustable by means of threaded plugs on brass rods.

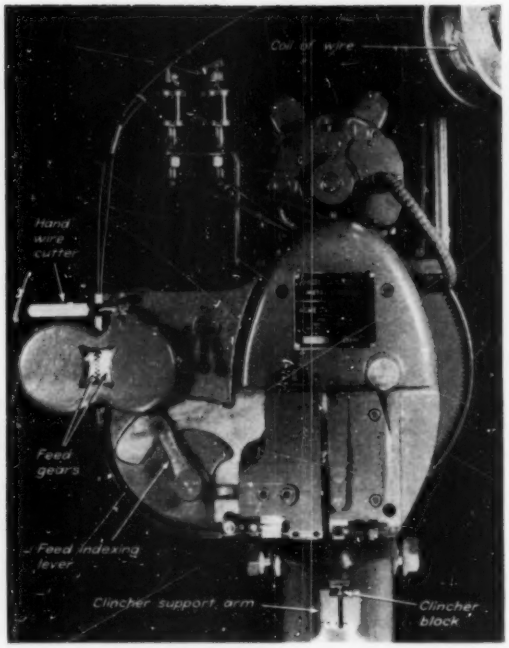


CONTINUOUS CHAIN SYSTEM transmits power from a ¾ hp drive motor to the heater and transfer drums. Separate chain drives take power from the same system to supply the feed screw and rolling pressure belt mechanism. Compressed air is normally supplied by house lines (5 psi) although a built-in compressor is also available. A ¾ hp motor is used to drive each of the 3 vacuum pumps. Operating vacuum is 15 in. Hg on transfer drum, 3-5 in. Hg on heater drum.

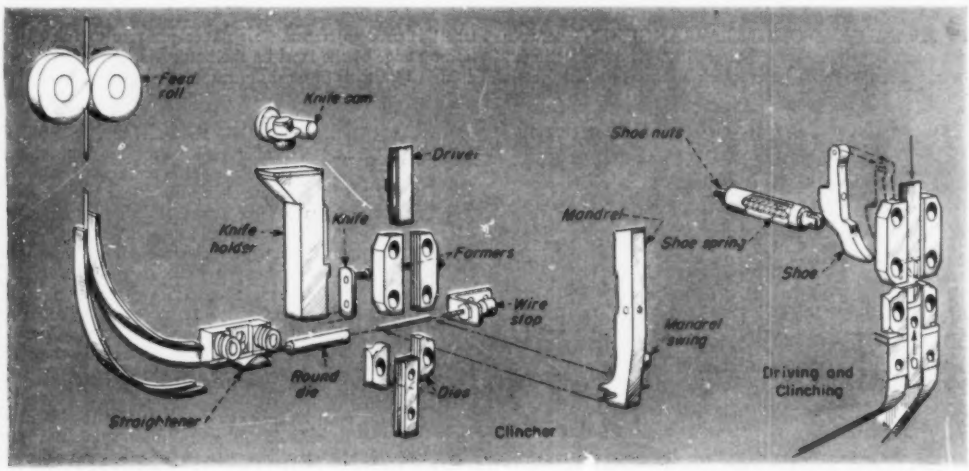
NO BOTTLE-NO LABEL MECHANISM has twofold action. If no bottle is present, it opens a port bleeding air into the vacuum line of the mouthpiece, and also prevents mouthpiece from pivoting to receive a label.

Stitcher Supports All Wire Surfaces During Driving

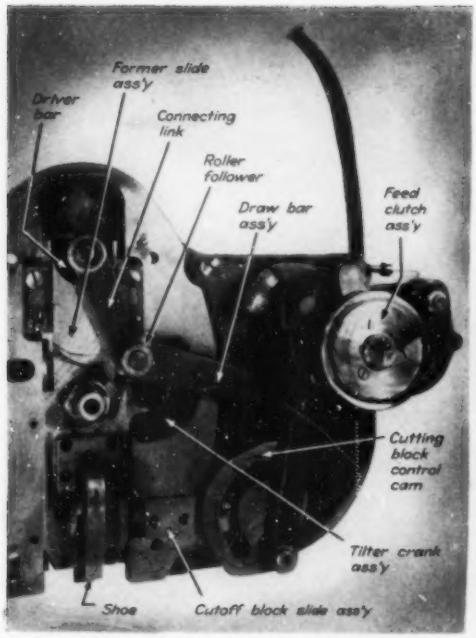
By supporting all surfaces of the metal stitch during the entire driving operation, this stitcher penetrates metallic and non-metallic combinations whose total thickness is 3 to 4 times the diameter of the stitching wire. Self-punched holes made by the stitches are clean and do not impair the fatigue properties or surface finish of the materials being joined. Designed and manufactured by the Acme Steel Company of Chicago, Ill., this machine requires only a 1/3 to 1/2 hp motor and can complete from 280-325 stitches per minute. On production applications, when time for set-up and positioning the work are included, from 80-100 stitches per min can be attained. Interchangeable, stationary clincher blocks provide for making standard and special type loop-clinched stitches. Activated, or moving clincher-blocks are available to make flat-clinched stitches whose legs are parallel to the work. Straight, overhang, drop goose-neck and reverse goose-neck clincher support arms permit stitching in places where other means of fastening are impossible. A 1/4 in. flange is sufficient for nearly any type of stitching operation.



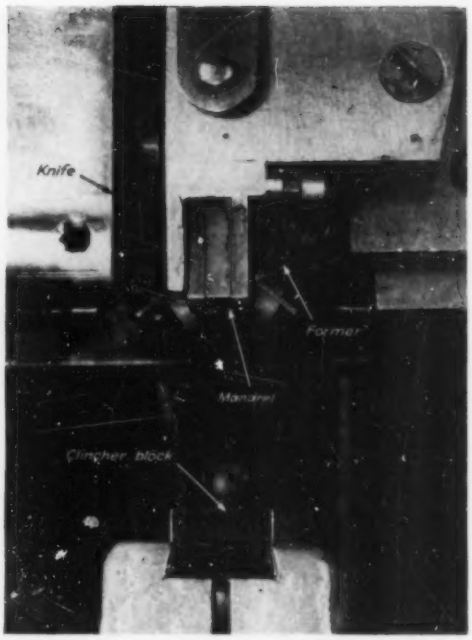
STITCHES ARE MADE SINGLY by means of a foot actuated pedal. Wire fed from coil is either 16, 18 or 20 gage, usually cold drawn or cold rolled steel although bronze, stainless steel or monel can be used. Feed indexing lever permits rapid change of stitch leg length by moving the cutting block such that more or less wire is allotted per stitch.



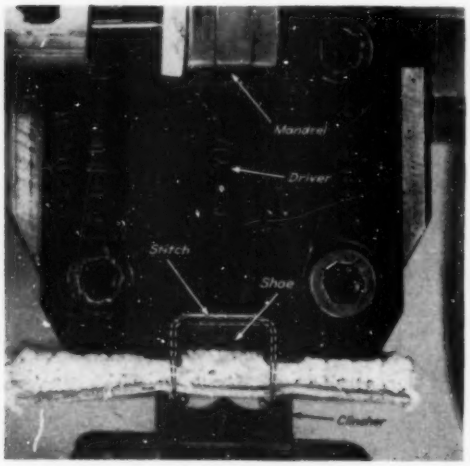
OPERATION with activated clincher mechanism is illustrated above. Predetermined length of wire is fed through two friction feed rolls, through a straightener and round shearing die which supports it while shearing knife cuts it off. Feed rolls are driven by an oscillating clutch. Wire is carried under the formers by a spring-actuated mandrel. As formers are moved downward by main cam (directly driven from flywheel), they form the stitch.



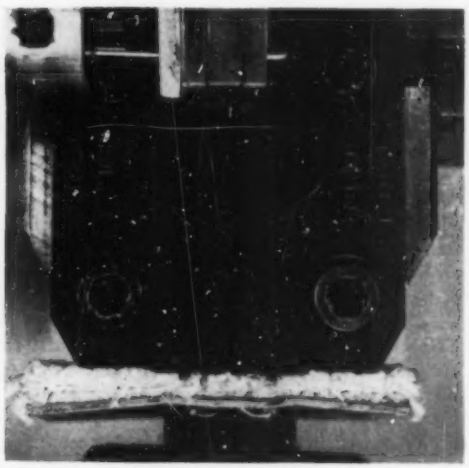
REAR VIEW of faceplate shows the main operating links. After the former shapes a stitch, mandrel is cammed out of position by the driver. Driver then forces the stitch through the material being joined. Driver is keyed to driver bar which is actuated by a roller follower that rides in an elliptical-shaped track on the main cam.

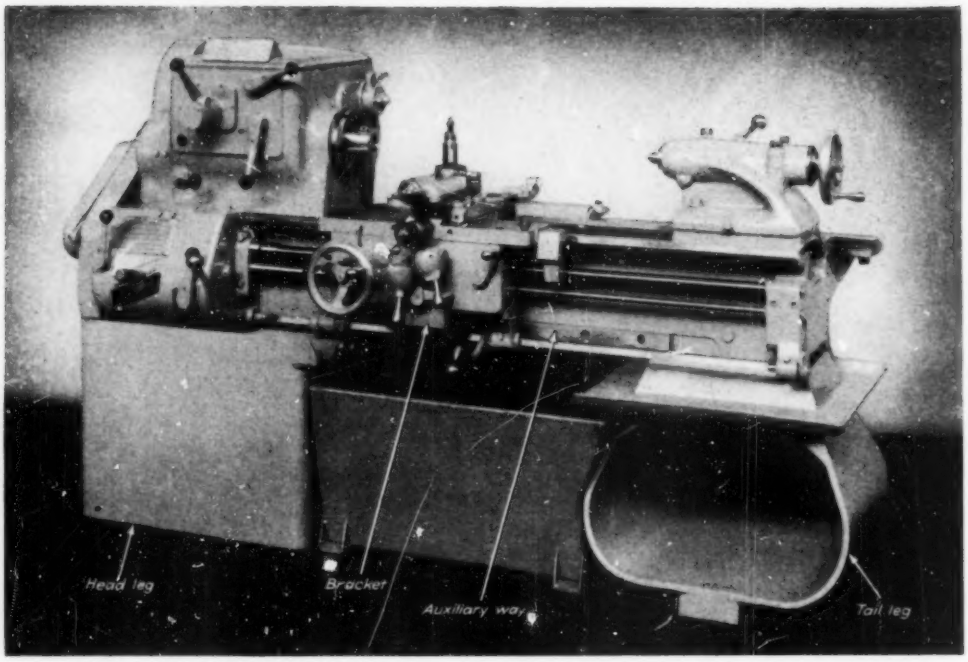


FORMERS are shown shaping a stitch by bending the wire over the mandrel. Clincher block shown is the stationary, closed type for loop-clinched stitches. While one stitch is being driven, the next length of wire is fed into the mandrel (in its forward position) and cut. Flat clinched stitches require activated clinchers (see previous page).



STITCH is shown supported on all sides as it is being driven through a metal-asbestos combination. Spring actuated roller follows the cam contour on the back of the shoe maintaining a positive contact between the shoe and the driver and providing full support to the crown and legs until the stitch is completed. Shoe is driven back progressively as driver contacts its forward, curved surface during the final phase of the stitching.

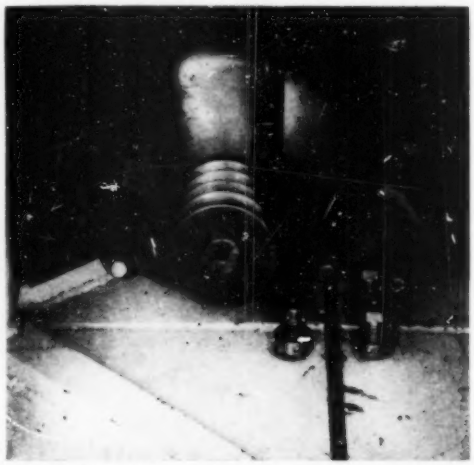




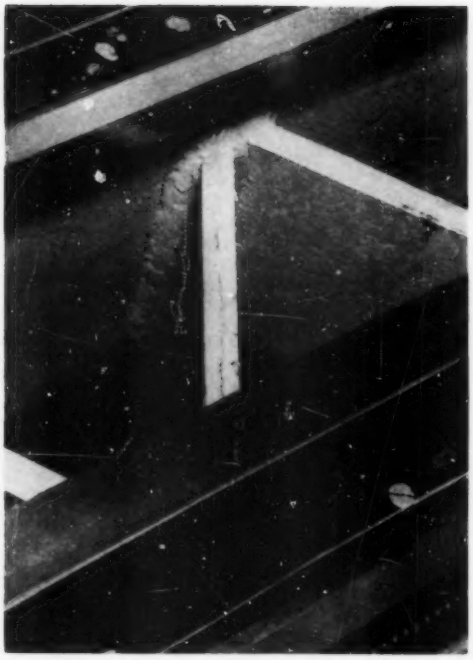
WELDED STEEL TAIL LEG is fabricated from $\frac{3}{8}$ inch steel plate. A 1 x 4 inch steel strip welded at its base forms a foot plate and has four holes for bolting this leg to the deck of a ship. Tail leg deflects under vertical shocks but will not transmit twisting stresses to the bed connected to it by gimbals. The bracket on the lower carriage apron clears the auxiliary way on the lower bed by 0.001 inches. If a transverse shock deflects the apron by this amount the bracket bears and transmits the shock to the bed avoiding fracture of the apron.

Welded Lathe Absorbs Shock Loads

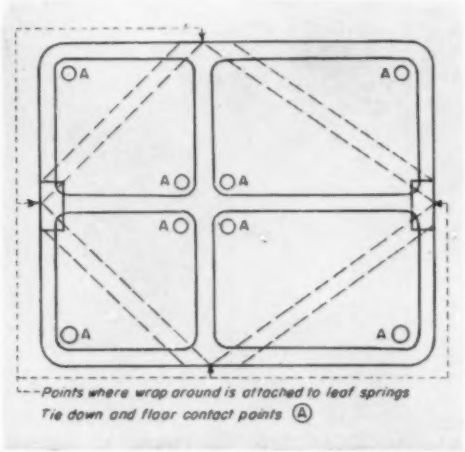
The use of welded steel legs and bed plus several unconventional design features permits this engine lathe to resist more severe conditions of shock, vibration and torsional stresses than was possible with a cast iron design. Although this machine is intended for Naval use and will be firmly bolted to a deck, these stresses are largely absorbed before they can distort the bed. The cast iron, bed-supported components (headstock, tailstock, carriage etc.) are identical to those used previously since these parts are relatively rugged and unlikely to be shattered except by a direct hit. Developed by cooperative efforts of The Lincoln Electric Co. and the Springfield Machine Tool Co., this lathe weighs about 300 lbs less than a similar cast iron one although no special effort was made to save weight.



HEAD LEG which supports the bed and houses the drive motor is a rigid box structure except for the floor which is made from four rectangular steel plates that are attached to the box at points marked *A* in the sketch (right). Plates



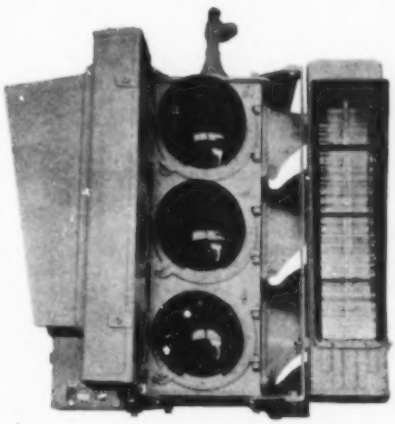
BED CONSISTS of two T-shaped steel beams supported by welded steel webs. Resulting triangular structure has about four times the stiffness of a similar cast iron bed. Gimbals at the tailstock end prevent torsional stresses from being transmitted to the bed from the legs.



function like leaf springs when loads are applied. The loads are transmitted at only four points, the midpoints of each side. At these points the box and spring plates are welded to diagonals that connect the points of attachment.

Vanishing Strip Light for Traffic Signal

Accessory for traffic lights introduces the element of time into the operation of standard signal systems. Any traffic signal now in use can be modified for the time feature without making costly, radical changes. Installation time of the unit is about 30 minutes. Replacement requires approximately 10 minutes. Externally, the Flo-Control is a vertical column of green light 5 in. wide and 24 in. long that weighs 40 pounds complete. When the green bullseye of the conventional signal flashes "on", the green column is fully lit. As the green bullseye "on-time" cycle expires, the column in the Flo-Control progressively blacks-out from bottom to top. The motorist therefore sees, at a glance, how much of the "go" period remains before the amber signal which is followed by the red.

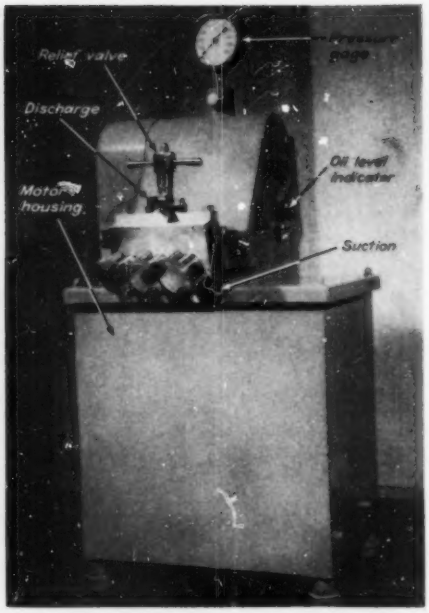


PRINCIPLE INTERNAL COMPONENT of the unit is a green, cold-cathode, fluorescent tube operated from a transformer and motor-driven contactor. As the latter rotates, contact with the tube's series of multiple electrodes is successively made and broken, blacking out the column in increments of three inches. The 1000-v secondary of the tube transformer insures a quick cold cathode start and a hermetically sealed relay provides quick cut-off from green to red. The auxiliary light can be seen clearly from a greater distance than can the standard traffic signal. The Lundberg Manufacturing Co., Inc. of Jackson, Michigan now has several of these units on test in the midwest.

Unique, Leak-Proof Pump Isolates Fluid Being Handled

Unique action of a completely sanitary pump, known as the Hydropulse, being manufactured by Scott & Williams, Inc. of Laconia, N. H. isolates the fluid being pumped from all actuating mechanisms. Pumping is accomplished by the expanding and contracting of synthetic rubber pulsators within stainless steel cylinder housings. The fluid comes into contact with no moving parts except the pulsators and stainless steel ball check inlet and exhaust valves.

Hydropulse pumps are particularly suitable for the transfer of pharmaceuticals, chemical, abrasive and corrosive materials, and when equipped with homogenizing valves, they are capable of processing materials. They are built in four sizes from 0.5 to 2.5 gpm for pressures up to 3,000 psi and temperatures up to 220 F. Work now underway will extend this range of pressures and volumes. This unique construction, which eliminates highly stressed parts since pressures on both sides of the pulsators are balanced, will also be applied to proportioning and metering equipment.

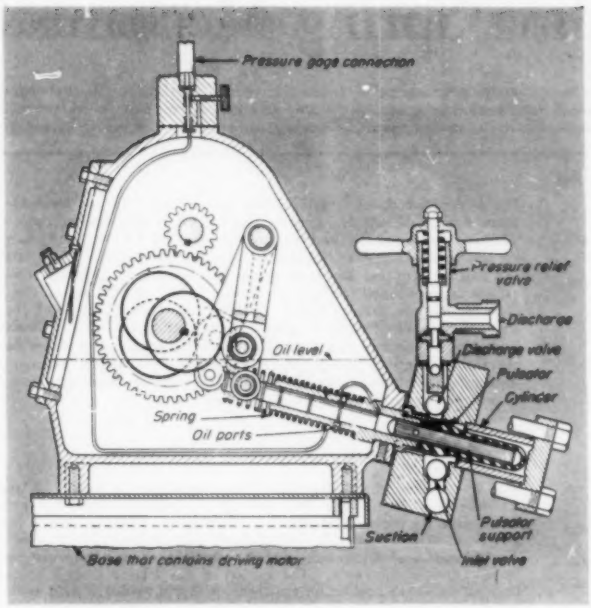


ACTUATING MECHANISMS are in the upper section of the motor housing and immersed in the actuating medium oil. Pump can be run dry without damage, is self-priming and leakproof. Materials with a wide range of viscosity can be handled.

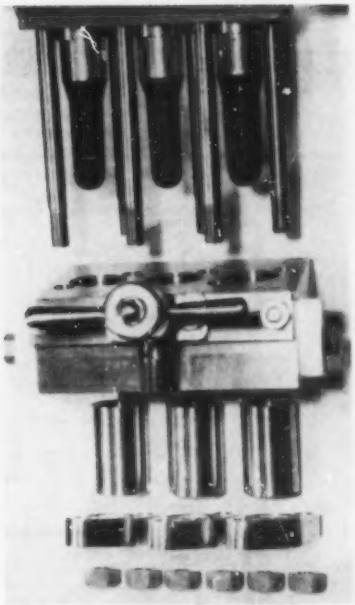
Redesigned Vaporizer Features Serviceability

Originally designed in England during the war to disperse germacide in air-raid shelters, this vaporizer was later redesigned there for insecticidal uses. Another redesign has now been effected for American Aerovap, Inc. of New York City to improve the service features and adapt the unit to U. S. production methods. With a capacity twice that of its British predecessor, the streamlined American model is equipped with a thermostatically controlled heating element that is insulated to prevent the conduction of heat to the wall through the mounting bracket. Operating on 115-125 ac-dc and rated at 125 watts, the Aerovap now utilizes a patented process with Lindane crystals and will keep a ventilated room measuring up to 20,000 cubic feet relatively free from small, flying insects. It is permanently attached to a wall or post, at least three feet below the ceiling or other overhead structure.

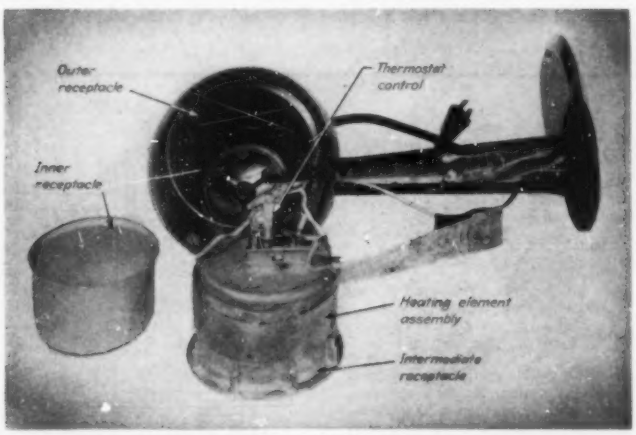
AMERICAN VERSION (below) has a bakelite housing to facilitate die casting. Thermostat which keeps a constant temperature of 110C can be adjusted from the outside. British model (above) is an expensive chrome plated brass casting with which thermostat controls must be removed to make adjustments.



AS GEAR DRIVEN CAM MOVES the piston to the right, oil pressure causes the rubber pulsator to expand, forcing material out of the cylinder through the discharge valve. When the piston is returned by the spring, oil pressure is relieved and the pulsator contracts onto its support creating a vacuum which draws material in through the suction valve.



PUMP CAN BE TORN DOWN, cleaned and reassembled in 10 minutes. All parts that contact the fluid being pumped are stainless steel except the pulsators. Maintenance is confined largely to valve wear.



REMOVEABLE BODY ASSEMBLY facilitates adjustments and replacement of parts without removing the entire machine from the wall. A terminal block in the mounting bracket permits the electrical leads to the switch and heating element to be removed independently of the supply leads. Horizontal thermometer well, accessible from outside, permits intimate contact between thermometer and inner receptacle, which contains crystals, for accurate temperature readings.

THERMOSTAT ADJUSTMENT TOOLS illustrate the three design stages. In the first stage, controls were removed to make adjustments. Latest wrench (lower) is more convenient to use and saves material.

Overriding Spring Mechanisms

Extensive use is made of overriding spring mechanisms in the design of instruments and controls. Anyone of the arrangements illustrated allows an incoming motion to override the outgoing motion whose limit has been reached. In an instrument, for example, the spring device can be placed between

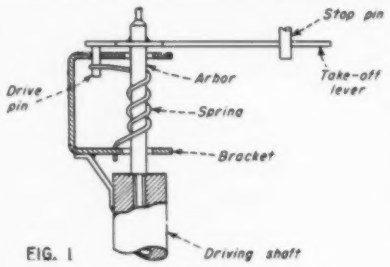


FIG. 1

Fig. 1—Unidirectional Override. The take-off lever of this mechanism can rotate nearly 360 deg. It's movement is limited by only one stop pin. In one direction, motion of the driving shaft also is impeded by the stop pin. But in the reverse direction the driving shaft is capable of rotating approximately 270 deg past the stop pin. In operation, as the driving shaft is turned clockwise, motion is transmitted through the bracket to the take-off lever. The spring serves to hold the bracket against the drive pin. When the take-off lever has traveled the desired limit, it strikes the adjustable stop pin. However, the drive pin can continue its rotation by moving the bracket away from the drive pin and winding up the spring. An overriding mechanism is essential in instruments employing powerful driving elements, such as bimetallic elements, to prevent damage in the overrange regions.

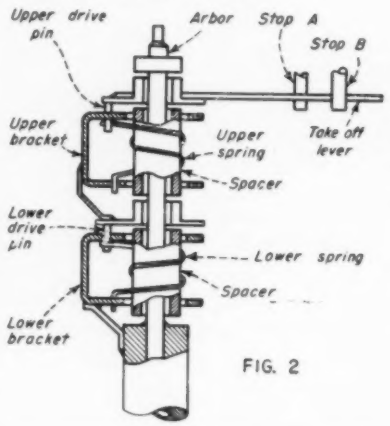


FIG. 2

Fig. 2—Two-directional Override. This mechanism is similar to that described under Fig. 1, except that two stop pins limit the travel of the take-off lever. Also, the incoming motion can override the outgoing motion in either direction. With this device, only a small part of the total rotation of the driving shaft need be transmitted to the take-off lever and this small part may be anywhere in the range. The motion of the driving shaft is transmitted through the lower bracket to the lower drive pin, which is held against the bracket by means of the spring. In turn, the lower drive pin transfers the motion through the upper bracket to the upper drive pin. A second spring holds this pin against the upper drive bracket. Since the upper drive pin is attached to the take-off lever, any rotation of the drive shaft is transmitted to the lever, provided it is not against either stop *A* or *B*. When the driving shaft turns in a counterclockwise direction, the take-off lever finally strikes against the adjustable stop *A*. The upper bracket then moves away from the upper drive pin and the upper spring starts to wind up. When the driving shaft is rotated in a clockwise direction, the take-off lever hits adjustable stop *B* and the lower bracket moves away from the lower drive pin, winding up the other spring. Although the principal uses for overriding spring arrangements are in the field of instrumentation, it is feasible to apply these devices in the drives of major machines by beefing up the springs and other members.

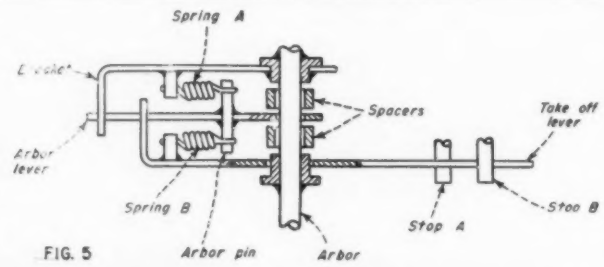


FIG. 5

Fig. 5—Two-directional, 90 Degree Override. This double overriding mechanism allows a maximum overtravel of 90 deg in either direction. As the arbor turns, the motion is carried from the bracket to the arbor lever, then to the take-off lever. Both the bracket and the take-off lever are held against the arbor lever by means of springs *A* and *B*. When the arbor is rotated counterclockwise, the take-off lever hits stop *A*. The arbor lever is held stationary in contact with the take-off lever. The bracket, which is soldered to the arbor, rotates away from the arbor lever, putting spring *A* in tension. When the arbor is rotated in a clockwise direction, the take-off lever comes against stop *B* and the bracket picks up the arbor lever, putting spring *B* in tension.

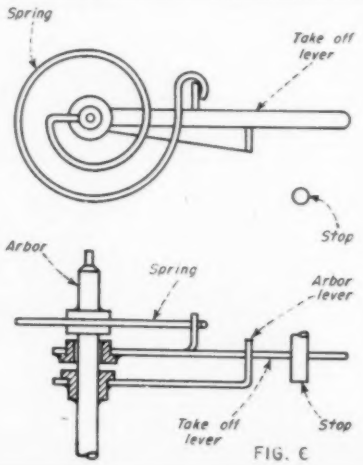


FIG. 6

for Low-Torque Drives

HENRY L. MILO, JR.
Division Engineer,
The Foxboro Company

the sensing and indicating elements to provide overrange protection. The dial pointer is driven positively up to its limit, then stops; while the input shaft is free to continue its travel. Six of the mechanisms described here are for rotary motion of varying amounts. The last is for small linear movements.

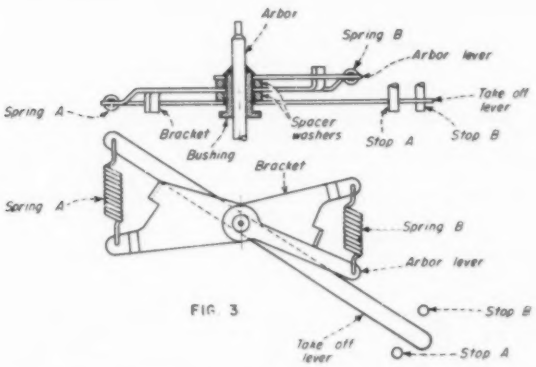


Fig. 3—Two-directional, Limited-Travel Override. This mechanism performs the same function as that shown in Fig. 2, except that the maximum override in either direction is limited to about 40 deg, whereas the unit shown in Fig. 2 is capable of 270 deg movement. This device is suited for uses where most of the incoming motion is to be utilized and only a small amount of travel past the stops in either direction is required. As the arbor is rotated, the motion is transmitted through the arbor lever to the bracket. The arbor lever and the bracket are held in contact by means of spring *B*. The motion of the bracket is then transmitted to the take-off lever in a similar manner, with spring *A* holding the take-off lever and the bracket together. Thus the rotation of the arbor is imparted to the take-off lever until the lever engages either stops *A* or *B*. When the arbor is rotated in a counterclockwise direction, the take-off lever eventually comes up against the stop *B*. If the arbor lever continues to drive the bracket, spring *A* will be put in tension.

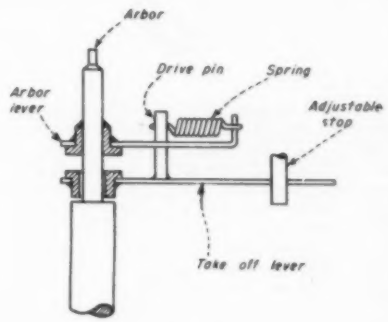


Fig. 4—Unidirectional, 90 Degree Override. This is a single overriding unit, that allows a maximum travel of 90 deg past its stop. The unit as shown is arranged for over-travel in a clockwise direction, but it can also be made for a counterclockwise override. The arbor lever, which is secured to the arbor, transmits the rotation of the arbor to the take-off lever. The spring holds the drive pin against the arbor lever until the take-off lever hits the adjustable stop. Then, if the arbor lever continues to rotate, the spring will be placed in tension. In the counterclockwise direction, the drive pin is in direct contact with the arbor lever so that no overriding is possible.

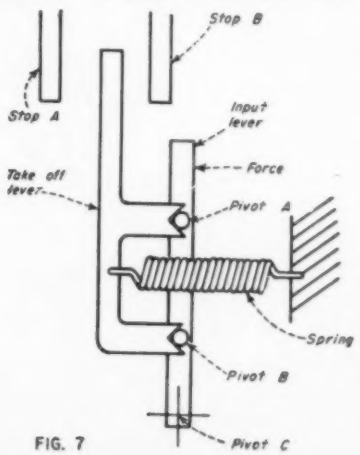


Fig. 6—Unidirectional, 90 Degree Override. This mechanism operates exactly the same as that shown in Fig. 4. However, it is equipped with a flat spiral spring in place of the helical coil spring used in the previous version. The advantage of the flat spiral spring is that it allows for a greater override and minimizes the space required. The spring holds the take-off lever in contact with the arbor lever. When the take-off lever comes in contact with the stop, the arbor lever can continue to rotate and the arbor winds up the spring.

Fig. 7—Two-directional Override, Linear Motion. The previous mechanisms were overrides for rotary motion. The device in Fig. 7 is primarily a double override for small linear travel although it could be used on rotary motion. When a force is applied to the input lever, which pivots about point *C*, the motion is transmitted directly to the take-off lever through the two pivot posts *A* and *B*. The take-off lever is held against these posts by means of the spring. When the travel is such the take-off lever hits the adjustable stop *A*, the take-off lever revolves about pivot post *A*, pulling away from pivot post *B* and putting additional tension in the spring. When the force is diminished, the input lever moves in the opposite direction, until the take-off lever contacts the stop *B*. This causes the take-off lever to rotate about pivot post *B*, and pivot post *A* is moved away from the take-off lever.

Pneumatic Governor Design for

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Associate Manager of Engineering and Research
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THE DESIGN AND CONSTRUCTION OF GOVERNORS for air turbines running at speeds from 30,000 to 200,000 rpm presents some interesting problems when the accuracy of regulation must be held within a few percent. The approach required in their design differs considerably from that associated with the usual concepts of flyweights, linkages and springs. When it is recognized that some parts of a conventional design, even though it be scaled down to watch works size, can be subjected to acceleration forces ranging from 25,000 to 100,000 gravity, it can readily be appreciated that the stresses and pivot frictions assume impractically large values.

A system that overcomes these difficulties, and that is stable and sensitive to the degree of being practically isochronous will be outlined in detail by reference to the design of the pneumatic governor shown in Fig. 1. The design of this pneumatic governor is comparatively simple, the governed speed is required to be adjustable between a low limit of 30,000 rpm and a top speed of 50,000 rpm, and the regulation must be held within 5 percent between idle and full turbine load.

The detail parts and the principle of operation are basically simple. Centrifugal force deflects a rotating cantilever spring attached to the turbine axis. The amount of spring deflection is a measure of the rotational speed. The deflection is measured precisely by an air gage. The air gage signal is sent to a servo throttle valve, which controls the power supply driving the turbine. A small drop in turbine speed, say as a result of increased load, reduces the cantilever deflection, which alters the signal to the servo. In response to this change in signal, the power supply is increased to maintain the speed nearly at the preset value.

A schematic diagram of the arrangement of essential parts of the governor is shown in Fig. 2. The main throttle is a piston and port urged toward the closed position by a spring S. Opposing the spring and tending to open the throttle is a servo piston subject to the chamber pressure p. At the right end of the turbine axis is a crenellated cup, which forms a ring or crown of small cantilevers. The outer ends of these cantilevers just clear the governor orifice A_2 and nearly seal it when the turbine is at rest.

Between the supply line P_1 and the chamber is an adjustable needle orifice A_1, the function of which is to control the flow of air into the chamber. This flow in turn escapes from the chamber through the governor orifice A_2. Because the chamber is intermediate between the two orifices it is under the intermediate pressure p, which can be made to vary from P_1 to atmospheric depending upon the relative constriction of the orifices. (See "Air Lubricated Bearings," PRODUCT ENGINEERING, August 1951, p 112.)

When the turbine is at rest and the governor orifice nearly sealed, the chamber pressure p is nearly P_1 and the throttle valve is open. When the

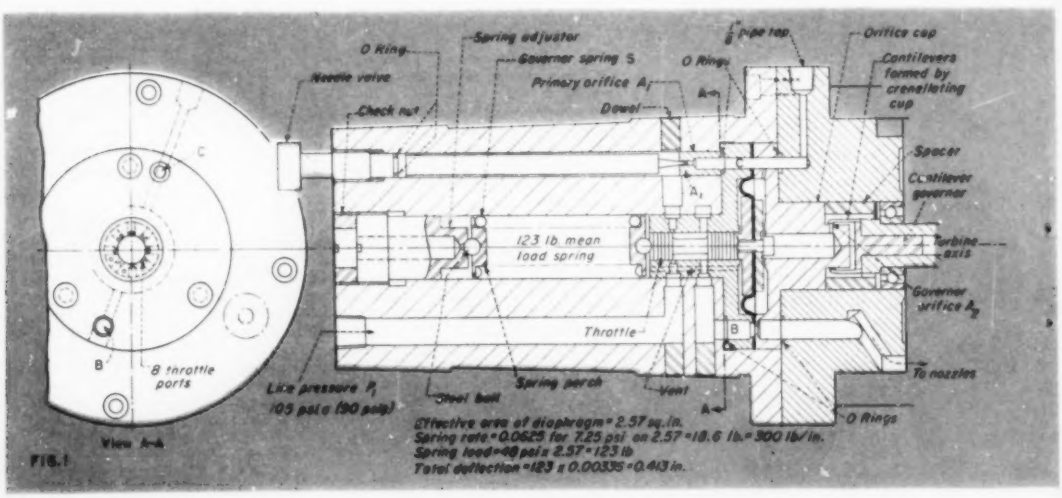


FIG. 1

High Rotational Speeds

Design of a specific pneumatic governor suitable for small high speed air turbines. Detailed calculations of the size of essential components and of governor's operating characteristics. Theory of the air gage and general rules for designing a pneumatic servo-controlled system to meet a required set of conditions.

turbine is running and picking up speed, the cantilevers spring away from the governor orifice, permit the chamber pressure to drop, and thus tend to close the main throttle.

It is evident that when the needle orifice A_1 is adjusted to pass only a small flow of air, the cantilevers will need to spring out only a small distance to reduce the pressure p to a throttling value. This adjustment corresponds to low speed operation. Contrarily, when the needle orifice is adjusted to pass a greater amount of air, the cantilevers must spring well away to reduce the chamber pressure to throttling. This adjustment corresponds to high speed operation. Hence, by adjustment of the needle orifice it is possible to determine the operating speed of the turbine.

Regulation and Stability

Calculation of the regulation or "droop" is quite involved and will be shown graphically after consideration of some of the other parameters. Because turbine windage at high speeds absorbs considerable power, the no load or idle condition has to be taken into consideration. The result is that the regulation is always better than calculated, therefore, it is simpler to design by cut and try and prove out graphically.

For the governor shown in Fig. 1, where the droop is to be kept less than 5 percent, the calculations are based on a droop of 6½ percent, which is improved to about 4½ percent by virtue of the high idle losses in the turbine. Because deflection of the cantilever is proportional to the square of the speed change, it is evident that the cantilevers will have a 10 percent displacement for the 5 percent droop, or the speed change from idle to full open throttle.

It will be apparent from the calculations which follow that the rate of stress build-up in the cantilever root is far faster than the increase of the gyration radius with speed. Hence, the beam itself is stable. The use of the spring S to buck the servo piston of the throttle valve insures stability in this part of the system. A droop type governor does not require any feedback mechanism, and because the simple cantilever can be made to work with a droop of 1 percent, if the conditions require, the complications of an isochronous type can generally be avoided.

In the calculations and discussion that follow, the nomenclature given in Table I will be used.

Proportions of Cantilever

The first step in the design of the pneumatic governor shown in Fig. 1 is to determine the dimensions of the cantilever springs.

In this design the specifications are:

Top turbine speed is 50,000 rpm.

Low limit of turbine speed is 30,000 rpm.

Radius of gyration of cantilever about turbine axis is 0.40 in.

Cantilever has a rectangular cross section of width b, thickness d, and length L.

Material in cantilever is steel having a density w of 0.28 lb per cu in., and a modulus of elasticity E of 29,000,000.

Stress s in the cantilever is limited to 80,000 psi maximum.

DESIGN PROCEDURE. The cantilevers are assumed to be subject to the same stress as in a uniformly loaded beam, or

$$s = G\,W\,L/2\,Z \qquad (1)$$

in which the product $G\,W$ is the dynamic weight.

The static weight of the beam is

$$W = L\,b\,d\,w \qquad (2)$$

The increase in gravity at a rotational speed of 50,000 rpm, and a radius of gyration of 0.40 in., is

$$G = 2.84 \times 10^{-6} \times 0.40 \times 25 \times 10^{8} = 28{,}400 \qquad (3)$$

Section modulus $Z = b\,d^2/6$ (4)

Combining Eqs (1), (2), (3) and (4), and substituting for w its value

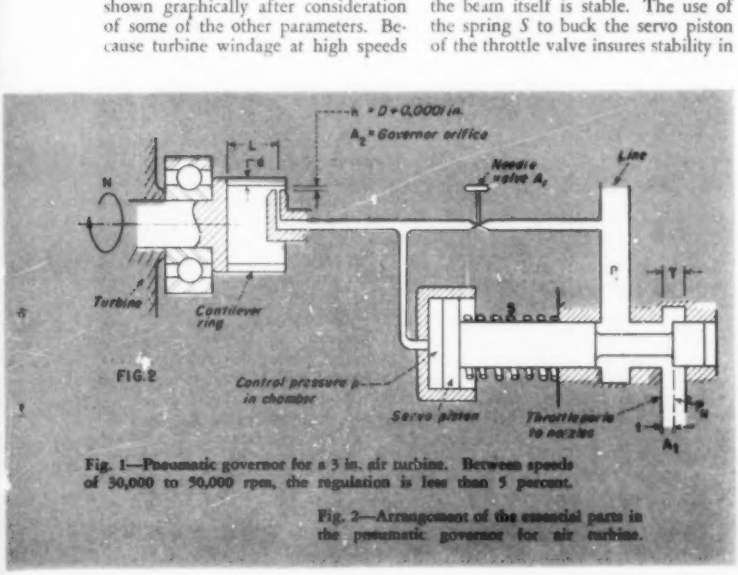


Fig. 1—Pneumatic governor for a 3 in. air turbine. Between speeds of 30,000 to 50,000 rpm, the regulation is less than 5 percent.

Fig. 2—Arrangement of the essential parts in the pneumatic governor for air turbine.

Table I—Nomenclature for Calculations

Dimensions are in inches
Areas are in square inches
Forces and weights are in pounds
Time is in seconds unless noted
Pressures are absolute in psi unless noted

- A = area
- A_1 = area of needle valve for speed control
- A_2 = area of governor orifice
- A_t = area of throttle when open t in.
- b = width of cantilever section
- d = thickness of cantilever section
- D = deflection at tip of cantilever
- D_i = deflection of cantilever at idle speed
- D_f = deflection of cantilever at full load speed
- E = modulus of elasticity, 29×10^6 psi
- f = subscript for full load or throttle
- G = ratio of dynamic to static weight
- h = lift of cantilever cover $= D + 0.0001$ in.
- h_i = lift at idle speed
- h_f = lift at load speed full throttle
- h_o = lift at speed at closed throttle
- i = subscript for idle load or throttle
- I = moment of inertia of cantilever section
- k = ratio of deflection to square of speed, D/N^2
- L = length of cantilever
- N = rotational speed of turbine, rpm
- N_f = droop speed at full throttle, rpm
- N_i = idle speed of turbine, rpm
- o = subscript for closed throttle
- P = pressure
- P_1 = line or supply pressure
- P_n = pressure in nozzle manifold
- p = control pressure on servo piston
- p_i = control pressure idle speed
- p_f = control pressure full throttle
- p_o = control pressure closed throttle
- Q = volume of air, cu ft
- R = ratio of pressure across nozzle or port
- $(f)^{1/2}$ = factor in flow formula (Fig. 3)
- S = throttle spring rate, lb/in.
- s = stress in root of cantilever, psi
- T = full open throttle port
- t = partially open throttle port
- u = density of material in cantilever, lb/cu in.
- W = static weight of cantilever or weight of air flowing, lb/sec
- Z = section modulus of cantilever

of 0.28, and solving for L in terms of d

$$L^2 = 3.355\,d \tag{5}$$

Let thickness of beam

$$d = 0.045 \text{ in.} \tag{6}$$

then from Eq (5), $L = 0.387$ in. (7)

Deflection at the tip of the cantilever is

$$D = G\,W\,L^3/8\,E\,I \tag{8}$$

where $I = bd^3/12$, and $E = 29{,}000{,}000$ (9)

Combining Eqs (2), (3), and (6) to (9) inc. and solving for D

$D = 0.0046$ in., at 50,000 rpm

$D = (3/5)^2 \times 0.0046 = 0.00165$ in., at 30,000 rpm

These deflections are the amounts the governor orifice A_2 is uncovered at the respective speeds, and will work satisfactorily with a governor orifice of approximately 0.031 in. diameter.

It is interesting to note that there is an upper limit in speed for which this type of cantilever can be designed. For a given material of density u and modulus of elasticity E, by combining Eqs (1), (2), and (4) the following relationship can be obtained

$$G\,u\,L^3 = s\,d/3$$

or $$L^3/d = s/3\,u\,G,$$

or $$L^4/d^2 = s^2/9\,u^2\,G^2 \tag{10}$$

Also from Eqs (2), (8), and (9)

$$G\,u\,L^4 = 8\,E\,d^2\,D/12$$

or $$L^4/d^2 = 0.67\,E\,D/u\,G \tag{11}$$

Combining Eqs (10) and (11)

$$D = s^2/6\,u\,E\,G \tag{12}$$

Thus, for a safe stress in a given material the deflection D is inversely proportional to the centrifugal factor G. But D has a low limit beyond which construction becomes impractically precise; hence, G has a high limit.

The factor $s^2/u\,E$ is a criterion of merit for the choice of material when designing toward the upper limit of speed. Tempered steel and beryllium copper show the best values of several materials investigated.

Design of Air Control System

The basic formula for adiabatic flow of diatomic gases is given and plotted in Fig. 3. Curve (A) shows the increase of flow from a line pressure P_1 into a chamber pressure p, as p is reduced until the critical pressure at 52.7 percent of P_1 is reached, after which the flow is steady and independent of back pressure. Curve (B) evaluates the value of the term $(f)^{\frac{1}{2}}$ for different values of the ratio r in the flow equation.

It will be noted that the flow is proportional to orifice area. Also that, when the back pressure is below the critical, the flow from a given orifice is proportional to the initial pressure P_1, since the term $(f)^{\frac{1}{2}}$ becomes constant at critical.

In Fig. 4 this basic flow equation is plotted in two forms to represent the conditions:

1. At needle orifice, from a steady line pressure P_1 to a variable chamber pressure p, and
2. At governor orifice, from a variable chamber pressure p to steady atmospheric pressure.

The group of horizontal lines the left hand ends of which curve downward represents the rates of flow from the steady line pressure P_1 into the chamber for several different areas of inlet orifice. These areas as plotted in Fig. 4 are arbitrary and are in the proportion 4, 5, 6, 7, and 8.

The two diagonal lines represent the rate of flow through two governor orifices having a difference of 10 percent in area. These flows are from chamber pressure p to atmosphere, and are linear until the chamber pressure reaches 28 psi, which is the pressure for which one atmosphere (14.7 psi) is critical.

It will be evident that the intersection of the diagonal lines with the horizontal ones represents the chamber pressure at which the flow through the inlet orifice balances the outgoing flow. For instance, the chamber pressure will be 40 psia when the No. 4 inlet orifice is used with the No. 10 governor orifice, and will drop to 36.4 psia if the orifice is opened 10 percent to the No. 11 rate.

This drop in pressure, which is caused by opening the governor orifice 10 percent will be used to move the main throttle valve.

By scaling the graph for the several values of differential pressure, and constructing the curve labelled "Sensitivity," the differential pressure is found to reach a maximum of 5 psi when the orifices are such as to give a chamber pressure of 60 psia.

From the graph of Fig. 4, several

important conclusions can be deduced:

1. The maximum change in differential pressure occurs when $p = 0.6P_1$
2. The maximum differential pressure $P_f - P_o = 0.05\ P_1$
3. $(P_f - P_o)/P_1 = 1/2$ of percent change in A_2
4. $A_1 = 0.6A_2$ for maximum sensitivity

When these general rules are applied to the specific case of the cantilevers calculated in the foregoing, the following conditions and relations hold.

The hole diameter of the governor and inlet orifices are assumed to be the same, and larger than six times the maximum lift of the cover, so that the flow will be influenced only by the lift and independent of the constriction of the hole. Because the maximum lift (or deflection) will be about 0.0047 in., a hole diameter of 0.03 in. or greater will be satisfactory.

Clearance between cantilever and orifice at 0 rpm	= 0.00010 in.
Deflection D of cantilever at 30,000 rpm	= 0.00165 in.
Lift h of cantilever at 30,000 rpm	= 0.00175 in.
10 percent of deflection	= 0.000165 in.
Percent change in lift is (165/1750) x 100	= 9.4
Ratio $(P_f - P_o)/P_1 =$ 9.4/2	= 4.7 percent
$(P_f - P_o)$ for P_1 equal to 105 psia	= 4.94 psi
Lift of inlet orifice A_1 is 0.6 × 0.00175	= 0.00105 in.

Clearance between cantilever and orifice at 0 rpm	= 0.00010 in.
Deflection D of cantilever at 50,000 rpm	= 0.00457 in.
Lift h of cantilever at 50,000 rpm	= 0.00467 in.
10 percent of deflection	= 0.000457 in.
Percent change in lift is (457/4670) × 100	= 9.8
Ratio $(P_f - P_o)/P_1 =$ 9.8/2	= 4.9 percent
$(P_f - P_o)$ for P_1 equal to 105 psia	= 5.15 psi
Lift of inlet orifice A_1 is 0.6 × 0.00467	= 0.0028 in.

Thus, it is seen that the initial clearance of 0.0001 in. introduces a discrepancy in the sensitivity between high and low speed as evidenced by the two values of $(P_f - P_o)$, which for low speed is 4.94 and for high speed is 5.15 psi, and that the differential is reduced from the theoretical maximum of 5.25 psi if there was no initial clearance. However, these reduced values are adequate because, as will appear in the following calculations, the diaphragm diameter can be of practical size and still provide ample force to move the main throttle.

Using the flow formula of Fig. 3, the amount of air wasted in the control is calculated as follows:

Diameter of governor orifice	= 0.031 in.
Periphery of governor orifice	= 0.098 in.
Lift of governor orifice at 50,000 rpm	= 0.0028 in.
Area of needle orifice, 0.098 × 0.0028	= 0.000274 sq in.
Discharge of nozzle 1 sq in. area at 105 psia	= 2.43 lb/sec
Discharge of needle orifice, 2.43 × 0.000274	= 0.00066 lb/sec
Discharge free air, 0.00066 × 60 × 13.2	= 0.53 cu ft/min

In the preceding calculations, no account has been taken of the effect of the gaps between the cantilevers in the crenellated ring. As the gaps pass over the governor orifice the restriction is momentarily lessened and the effectiveness of the cover reduced. The result is a reduction in sensitivity similar to that introduced by the initial clearance of the cantilever.

For the design under discussion the gap is 0.003 in. and the width of cantilever is 0.140 in., so that the discrepancy introduced can be neglected. For other cases, this factor may have to be taken into account.

To summarize, at this point the following data have been determined:

1. The dimensions of the cantilever, 0.045 × 0.387 × 0.14 in.
2. The deflections for low and high speeds, 0.00165 in. and 0.00457 in., respectively.
3. The most sensitive control pressure, 63 psia.
4. The differential control pressure,

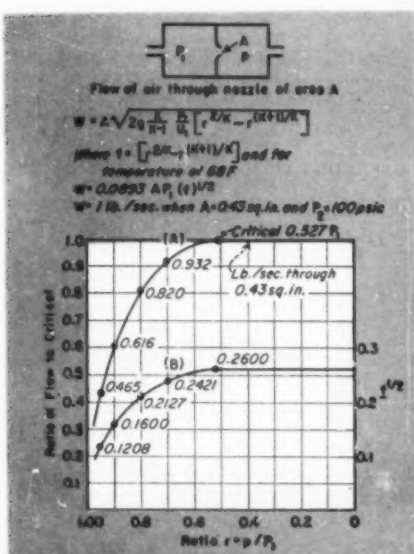


Fig. 3—(A) Flow from steady line pressure into variable chamber pressure until critical pressure is reached. (B) Plot of pressure ratio function.

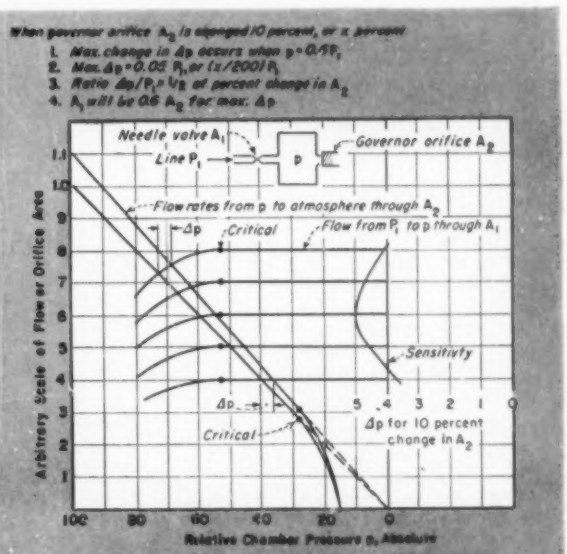

When governor orifice A2 is opened 10 percent, or x percent
1. Max. change in Δp occurs when p = 0.6P1
2. Max. Δp = 0.05 P1, or (x/200) P1
3. Ratio Δp/P1 = 1/2 of percent change in A2
4. A1 will be 0.6 A2 for max. Δp
Needle valve A1
Line P1
Governor orifice A2
Flow rates from p to atmosphere through A2
Flow from P1 to p through A1
Critical
Δp
Sensitivity
Δp for 10 percent change in A2
Arbitrary Scale of Flow or Orifice Area
Relative Chamber Pressure p, Absolute

Fig. 4—Flow at needle orifice from a steady line pressure to a variable chamber pressure; and flow at governor orifice from a variable chamber pressure to steady atmospheric pressure.

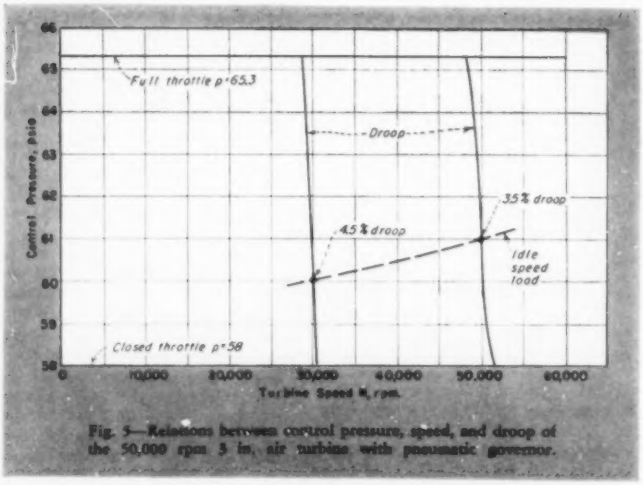


Fig. 5—Relations between control pressure, speed, and droop of the 50,000 rpm 3 in. air turbine with pneumatic governor.

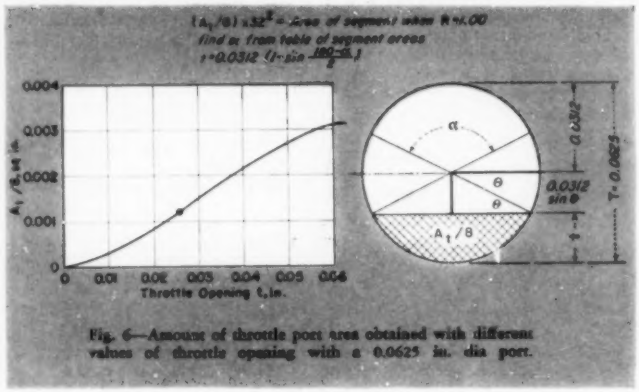


Fig. 6—Amount of throttle port area obtained with different values of throttle opening with a 0.0625 in. dia port.

approximately 5 pounds per square inch.

A check test of an air gage set up to duplicate these conditions as nearly as possible gave the following:

Most sensitive control pressure, 58 psia
Differential control pressure, 4.4 psi

These values are close enough to the theoretical calculations to prove the validity of the formulas used.

Proportions of Throttle and Servo

The design of the throttle and servo of the control shown in Fig. 1 may be done easily by trial and error followed by proof using comparatively simple formulas.

In the foregoing discussion of the cantilevers, it was seen that the initial clearance over the governor orifice upset the theoretically uniform regulation to a small degree. To a still greater degree, the idle power requirement (to overcome windage) affects the regulation.

In Fig. 5 the relationship of the control pressure, speed and droop lines is shown. If the turbine had no windage or other idle losses, the speed for various throttle positions (loads) would vary according to the whole droop line. For instance, the turbine idling at 51,600 rpm would slow down to 48,200 rpm under a load requiring full throttle, and the regulation would be 482/516 or 0.935, or 6.5 percent droop.

Actually, the no load losses are so high that the throttle must be opened appreciably to supply them. Hence, the speed range from idle to load is only that portion of the droop line above the intercept of the idle speed line. The regulation for this condition is 482/500 or 0.965, or 3.5 percent droop.

Similarly, for a speed near 30,000 rpm where there is less windage loss, the droop is 4.5 percent.

The interrelations of these curves, the equations for which are impossibly complex, is the reason for solving by cut and try rather than by direct formula.

The 3 in., 50,000 rpm turbine, equipped with the governor under discussion, has four 0.080 in. nozzles open to the wheel, or 0.0205 sq in. total nozzle area.

For a line pressure P_1 of 90 psig (105 psia) the nozzle manifold pressure P_n is to be at least 75 psig (90 psia) for full throttle.

Flow of air from a nozzle pressure P_n of 90 psia to atmosphere

$$W = (0.0205 \times 90)/(0.43 \times 100) = 0.042 \text{ lb/sec}$$

The same quantity must pass the throttle when P_1 equals 105 psia and P_n equals 90 psia, for this condition

Ratio $r = 90/105 = 0.855$ and $(f) = 0.187$

$$W = 0.042 = 0.0893 \times 105 \times A_t \times 0.187$$

$$A_t = 0.042/1.75 = 0.024 \text{ sq in.}$$

Area of eight 1/16 in. throttle ports, see Fig. 1, is

$$A_t = 8 \times \pi \times 0.062^2/4 = 0.0245 \text{ sq in.}$$

Area of the power piston is 2.57 sq in.

Throttle port dia T is 0.0625 in.

Rate of the spring S is 300 lb/in.

hence $2.57 \times (p_f - p_o)/0.0625 = 300$ lb/in.

and $(p_f - p_o) = 300 \times 0.0625/2.57 = 7.3$ psi

This value is higher than the 5 psi needed for 5 percent regulation as calculated previously in the design of air control system. Fig. 5 indicates the reason for this discrepancy.

True Regulation

With the cantilevers and the throttle valve both dimensioned, it is now possible to determine the true regulation.

Presume that the turbine is running idle at a speed of 50,000 rpm and that the spring S of the throttle valve has been adjusted so that the throttle just closes (t is 0) when the control pressure p_o is 58 psia, the control pressure for full throttle then is

$$p_f = 58 + 7.3 = 65.3 \text{ psia}$$

From tests it was determined that the nozzle pressure P_n must be 50 psia and the discharge 0.0235 lb/sec to maintain this idle speed against windage.

Then for

$P_1 = 105$ psia, $P_n = 50$ psia, and $(f) = 0.26$

$$W = 0.0235 = 0.0893 \times 105 \times 0.26 \times A_t$$

The area of the throttle ports must be

$$A_t = 0.0095 \text{ sq in.}$$

and the partial area of each 1/16 in. throttle port must be

$$0.0095/8 = 0.00199 \text{ sq in.}$$

From chart Fig. 6 this area is opened when t is 0.0258 in. To open completely, the throttle must travel

$$0.0625 - 0.0258 = 0.0367 \text{ in.}$$

$$(p_f - p_i) = 7.3 \times 0.0367/0.0625 = 4.28 \text{ psi}$$

and the idle throttle pressure is

$$p_i = 65.3 - 4.28 = 61.02 \text{ psi}$$

When the needle valve A_1 has been set for a given speed

$$p_i h_2 = p_1 A_1 = \text{constant}$$

and since A_2 is proportional to h

$$p_h = \text{constant}$$

hence $p_f h_f = p_i h_i$

and $h_f = p_i h_i / p_f$

$h_f = 61.02 \times 0.00467/65.3 = 0.00437$

less initial clearance $= 0.00010$

Deflection at full throttle $D_f = 0.00427$

since $D = kN^2$

$D_f/D_i = (N_f/N_i)^2$

or $(N_f/N_i)^2 = 0.00427/0.00457$

$= 0.935$

$N_f/N_i = 0.965$

Hence, the regulation at 50,000 rpm is 0.965, or 3.5 percent droop.

Similar calculations for the low speed of 30,000 rpm are as follows: From tests it was determined that

$P_a = 29$ psia and $W = 0.0136$ lb/sec

$A_i = 0.0136/(105 \times 0.0893 \times 26)$

$= 0.0055$ sq in.

Port area is 0.0055/8, or 0.00688 sq in.

$t = 0.0172$ in., from Fig. 6

To open completely, the throttle must travel

$$0.0625 - 0.0172 = 0.0453 \text{ in.}$$

$$p_f - p_i = 7.3 \times 453/625 = 5.3 \text{ psi}$$

$p_i = 65.3 - 5.3 = 60$ psi

$h_f = 60 \times 0.00175/65.3 = 0.00161$

less initial clearance $= 0.00010$

$D_f = 0.00151$

$(N_f/N_i)^2 = 0.00151/0.00165 = 0.915$

$N_f/N_i = 0.955$

The regulation is 0.955 or 4½ percent droop.

Conclusion

In the foregoing discussion, a specific design of governor suitable for a small turbine has been defined and its operating characteristics calculated in detail. Its only rotating part is simple, stable under the high centrifugal forces involved, and not penalized by sliding friction.

The servo throttle valve can be proportioned so that its sliding resistance is negligible in comparison with the motor forces.

The underlying theory of the air gage has been explained and several general rules given so that it is possible to design a system to meet a given set of conditions, at least to a first approximation.

The primary regulation rate is seen to be dependent on the rate of the servo spring, the throttle travel from closed to full, and the control pressure differential on the servo piston. All other things being constant, the primary regulation is improved when

1. The spring rate is reduced.
2. The throttle travel is reduced.
3. The differential control pressure increased.

The effect of the necessary initial clearance between the cantilevers and the governor orifice is to cut down the differential control pressure and thus increase the primary regulation. This factor will become of greater importance as the design speed is increased and smaller cantilever deflections result.

The effect of the idle load in improving the primary regulation to its true value has also been shown.

The effect of the necessary slots in the crenellated cantilever ring on the sensitivity was mentioned. This factor will have to be taken into account with increased design speed.

It is shown that as the design speed is increased, or rather, as those factors which affect G increase, the amount of total deflection is reduced. This condition leads to an upper limit for speed, when the design of the cantilevers and their mounting relative to the governor orifice must be impractically precise to obtain a reasonable sensitivity. This condition can be ameliorated by a choice of cantilever material selected according to the factor of merit.

Note: The foregoing article entitled "Pneumatic Governor for High Rotational Speeds" and the article by the same author entitled "Air Lubricated Bearings" appearing on pages 112 to 115 inclusive in the August 1951 number of PRODUCT ENGINEERING constitute descriptions of devices forming the subject matter of applications for patent assigned to the Company with which the author is associated.

Miniature Piezoelectric Accelerometer Uses Barium Disk

THE NATIONAL BUREAU OF STANDARDS has developed a miniature piezoelectric accelerometer which measures high-frequency vibrations directly and also checks the frequency response of vibration generators. Although the device is extremely small, it is in many ways superior to instruments now used to measure mechanical vibration and shock. Its construction is so simple that it can be produced for only a fraction of the cost of a conventional pickup.

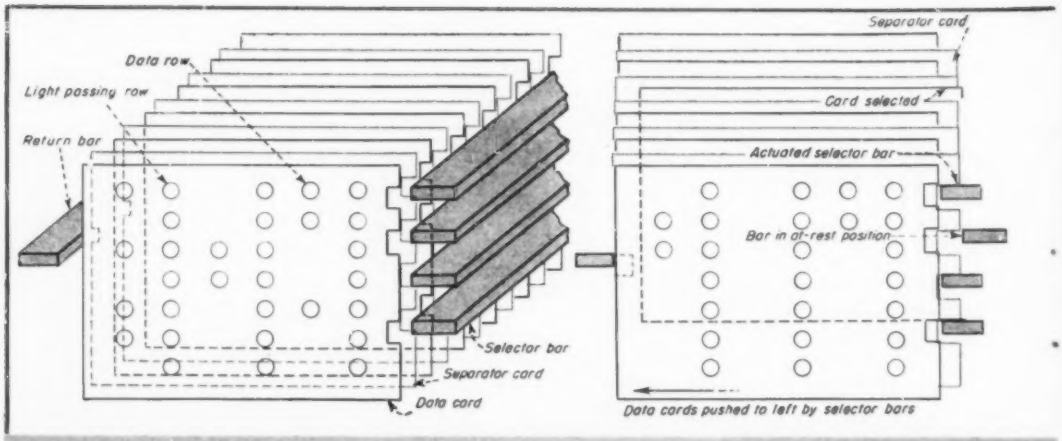
The new accelerometer, which employs a barium titanate piezoelectric compressive element, was developed by L. Fleming and E. J. Regan under an NBS program sponsored by the Navy, Air Force, and the Atomic Energy Commission. The piezoelectric compressive pickup is designed to detect a variety of vibratory movements. The unit responds to the characteristic vibration-frequencies generated by faulty bearings in an electric motor. And is useful for calibrating other vibration pickups, shake tables, and low-frequency noise detecting devices. It is not intended for seismic, aircraft, or vehicular accelerations.

A typical pickup is composed of a barium titanate disk $\frac{1}{8}$ inch thick and $\frac{3}{8}$ inch in diameter, stacked between a suitable base and a block of metal used for mass-loading the disk. The complete unit weighs less than 1/10 of an ounce. As a result of the "stacking" any acceleration imparted to the base produces a proportionate charge in pressure on the piezoelectric disk.

The voltage generated is proportional to the acceleration of the device being measured and is independent of its characteristic frequency up to the mechanical resonance of the accelerometer. This resonance has been extended to above 20,000 cycles per second by using a small and rather monolithic structure. As a voltage source, this pickup has an almost purely capacitive internal impedance of about 500$\mu\mu$f and a sensitivity of about 2 mv per g.

Calibration measurements indicate that the accelerometer has a response flat within 20% over the range 50 to 600 cycles per second, and rising to a slight peak between 10,000 and 18,000 cycles per second.

To provide electrical connections the disk is coated with a silver paint, then baked in a furnace at 1300°C for about 15 minutes, and finally it is polarized, or sensitized. This last process is accomplished by cooling the material through its Curie point of 120°C while a d-c potential gradient of about 10,000 volts per centimeter is maintained between its faces.



1. Sketch of random access punched card memory system with selector bars in the neutral position. All data cards are stacked evenly at their right hand position in the file. Above cards have three data rows.

2. Several selector bars have moved to the left, pushing all data cards—except one—with them. The bars to be moved are determined by the coded notches in the right hand edge of the desired data card. Separator cards do not move.

New Electro-Mechanical System Provides . . . .

Fast Access to Punched

The punched card is a proven low cost means of storing information in coded form. Already widely applied in the field of business machines, these cards figure in the coming machine bookkeeping and automatic factory developments.

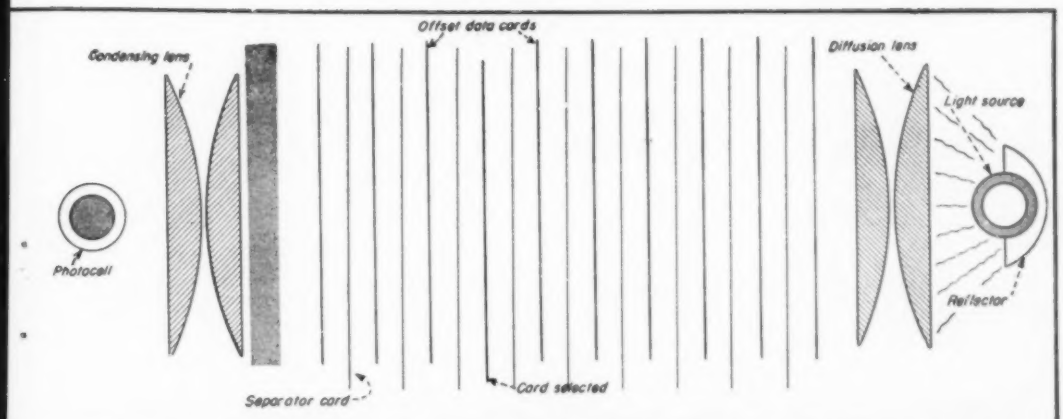
CLOSELY ALLIED with the problem of storing masses of data in automatic memory devices is the task of isolating a specific portion of the information when it is required. An ideal storage system would include provision for instantaneous location of wanted data, without the necessity of inspecting individually every item in the memory. This facility is an outstanding feature of the "punched card random access memory".

Most memory systems, such as those employing magnetic drums, photographic film, cathode ray tubes or magnetic tape require that blocks of data be scanned until the desired piece of information is found. Scanning must therefore be accomplished at high speed, and a certain amount of time must elapse before the desired information is made available. High-speed scanning usually involves costly apparatus. In addition to high speed scanning, searching time can be lowered by limiting the storage capacity of the memory.

In the punched card random access file, there is no scanning through unwanted data. The desired card is isolated instantaneously by an "edge selection mechanism"—a group of bars that push against the sides of the cards. The searching time is therefore reduced to the time required for the edge selecting mechanism to operate. Since high speed scanning techniques are not employed, the desired piece of information may be read at a convenient speed, slow enough to operate mechanisms, such as printers or adders, directly, without any intermediate storage. This will help to lower the overall cost of the installation. On this same subject of cost it should be pointed out that the punched card and perforated paper tape are among the cheapest of the memory systems on a per digit basis.

As in any punched card system, the coded data in the random access memory are impressed on the cards in the form of vertical rows of perforations. Beside each row of data holes on the card is a second line of holes that signify no information. These serve only as passageways for a light beam through the stack of cards. The beam of light is employed for reading the coded information contained in the data holes.

Every data card has an arrangement of notches on one or more of its edges. The pattern of notches is different for each card in the stack and serves to identify the information contained thereon. The selecting mechanism can locate any card immediately through the means of these edge notches. The cards are stacked together and placed in a file box which contains the card selecting and reading mechanisms. The insertion of any new card into the file-stack does not entail the placing of the card into a



3. Data holes in the chosen card are read by the light beam, which reaches photocell without interference from the remaining data cards. Light passing holes in these cards are in alignment with data holes in the selected card. Dark vertical bar to the left of the stack of cards represents the scanning device. This uncovers one of the data hole positions at a time that the photocell can "read" them individually. One cell serves all digit positions.

Card Data File

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particular spot in the stack, as the cards need not be arranged in order. The cards are locatable by the edge notches.

Alongside the notched sides of the data cards are a group of bars that run the length of the stack. In the at-rest or neutral position, the bars are positioned in a straight line, one atop the other. For selection, one or more of the bars, depending on the pattern of notches in the sought after card, are offset from the remainder. These push all of the data cards, except the one that is to be read, off to one side. The pattern of notches in the wanted card is such that all of the offset bars move within these notches and hence do not contact the edge of this card. On the other hand, the edge of each of the remaining cards is in contact with at least one of the selector bars that were shifted. By this means, the wanted card is made available immediately for reading. After the selected card is read, the remaining cards are returned to their normal position.

So that the cards that are adjacent to the selected card do not drag the selected card along through friction, separator cards are provided between the data bearing cards. These separator cards contain no information holes and are fully notched so that they are not moved by any of the bars. They are, however, furnished with rows of holes for the passage of the scanning light beam. When all save one of the data cards are offset for a reading operation, these rows of holes are in alignment with the arrays of light-passing holes in the displaced data cards.

In an alternative scheme, all cards need not be shifted during each selection. To accomplish this, two sets of offsetting bars are installed in the system, one set on each side of the stack. Actuation of the first set pushes one-tenth or one twentieth of the total number of data cards to one side. The operation of the other group of bars moves all of the offset cards back to their original position, except the one card that was required for scanning.

Scanning

Once the selector bars have isolated the wanted card, it is in position to be read. The data holes in this card are lined up with the light-passing holes in the separator cards and in the remainder of the data cards. The beam of light can thus pass from the source through holes in one portion of the cards up to the data holes in the offset card. Here, the scanning beam is broken into pulses in accordance with the pattern of the data holes. Then, these pulses pass uninterruptedly through the holes in the rest of the stack of idler and data cards to the photo cell. The latter translates the light pulses into usable intelligence.

A typical card may contain as many as 20 or more vertical data columns. Each of these data columns may also contain as many as 20 or more digit positions between the top and bottom of the card. A digit position may be punched or not depending on the information to be recorded. The term scanning implies that the photo cell "looks" at each digit position individually and in sequence.

If separate photocells were employed for each digit position in the card, scanning would not be necessary. However, such an arrangement would certainly prove very costly. In addition, a system employing cards with 400

digit positions (20 up and 20 across) would use a total of 400 phototubes and associated amplifiers. A system with so many phototubes and amplifiers is a physical impossibility, unless the smallest photocells or photo transistors were used. In the latter case, the light intensity might prove troublesome. From this it can be seen that the only practical alternative is a system incorporating a single photocell, possibly a photo-multiplier tube, and a scanning process.

In Fig. 4, a possible scanning device is shown. This scanner employs a number of vertical shutter blades and a number of horizontal shutter blades. Each shutter blade has two positions, a normal and an off-normal position. When a single vertical shutter and a single horizontal shutter are actuated, only the one digit position which is at the intersection of the two actuated shutters is unmasked, while the remaining digit positions on the card remain masked. Thus, although light is falling on all digit positions simultaneously, only one position is observed by the photocell at any given instant. Since there is a definite sequence in the scanning, the shutters may be tripped by cams (not shown). The shutters have little mass and can therefore be actuated at high speed.

In the drawing, Fig. 4, the horizontal and vertical shutters are supported in a rectangular frame. The horizontal shutters contain regularly spaced holes. Individual springs retain their shutters in their normal position. The shutters are thin blades which are so cut that they have a positive stop against the supports in either direction. The blades can be moved from the normal position by a push or pull action. A single timing motor can be used to drive the actuating cams. The cams needed to operate the vertical shutters are mounted on a single horizontal rod running along the top or bottom of the frame. A second rod, at right angles to the first, carries the cams for the horizontal shutters. The rods are gear driven, so that the cam rod for the horizontal shutters rotates more slowly than that for the vertical. The speed ratio depends on the number of vertical shutters. If there are 10 vertical shutters, the ratio is 10 to 1. Thus, each time a horizontal shutter is shifted to the off-normal position, it is held there while all vertical shutters are depressed in sequence.

The photocell and amplifier converts the light pulses resulting from the scanning operation into an electrical signal. There are numerous existing types of apparatus capable of decoding the electrical signal. A teletypewriter, for example, will translate the electrical pulses into a printed message. Or, the pulses representing digits can be fed directly into a computer. In machine applications, the electrical signal could be made to control the operations of a machine tool via a servo system. Still another use for the electrical pulses is to actuate a telephone type rotary switch. This selector switch would energize anyone of 10 or more circuits, depending on the coded information contained on the card being scanned.

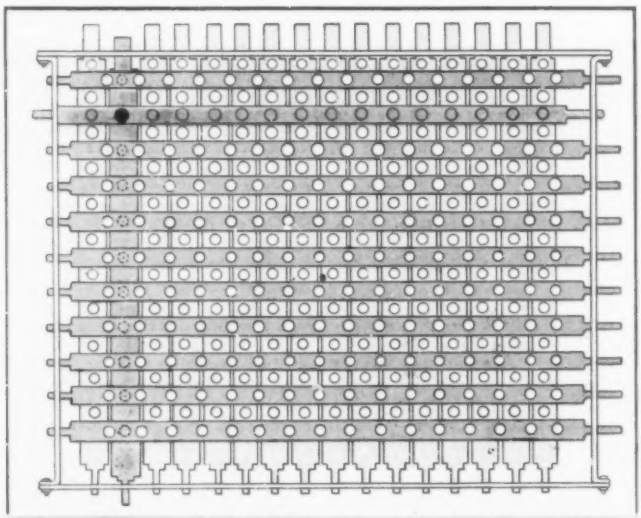


Fig. 4—Scanning mechanism uncovers only one digit position at a time. When one vertical shutter and one horizontal shutter are in the actuated position, the holes at their intersection are in alignment. Light can pass through these holes, but is blocked at all other portions of the scanner.

Estimated Storage Capacity

The factors controlling the storage capacity of the punched card random access memory are the following:

a) The size of the card.

b) The number of holes per linear inch.

c) The number of cards which may be stacked per inch.

d) The possible length of the stack of cards.

In determining the size of the card, the ease of handling the cards and the weight of the mass must be considered. Card sizes ranging from 5 x 8 in. to 10 x 15 in. seem practical. The total number of cards that can be accommodated is related to the number of notch combinations available (or the number of selector bars) and the mechanical forces available for actuating the bars.

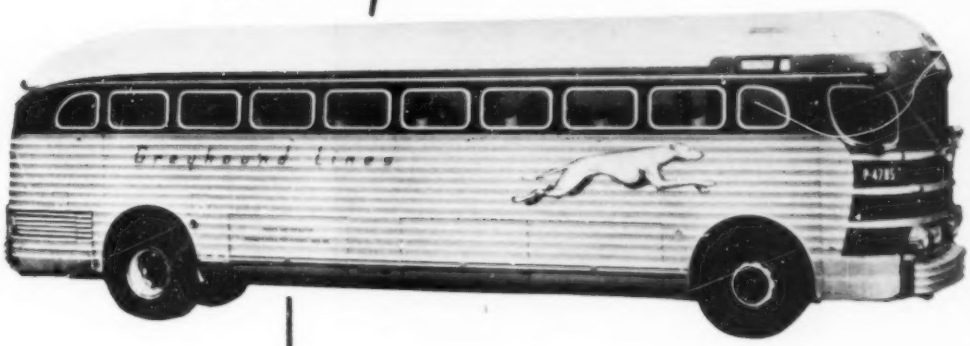
In determining the number of holes which may be contained per linear in., practical dimensions for the card, the file box and the offsetting and reading mechanisms are contributing factors. The possibilities range from three holes per linear inch to 10 holes per linear inch.

The number of cards which may be stacked per inch depends on the thickness of the card stock and the amount of looseness in stacking needed for easy manipulation of the cards. Practical quantities are 100 to 140 cards per inch. The lengths of the stack of cards may be from 12 to 24 inches.

A conservative selection of some of the lower of these values yield some indication of the capacity of this system.

Using a card 6 x 9 in. bearing four holes to the linear inch (with a ½ in. margin on all sides); stacking 120 cards per inch (60 data cards and 60 separator cards); and employing a file-stack length of 12 in., a total of 230,400 binary digits may be stored. This total is increased considerably by selecting some higher values for the design. Using a card size of 8 x 11 in., containing six holes per inch; 140 cards stacked per inch (70 data cards and 70 idler cards); and employing a file-stack of 15 in., a quantity of 1,323,000 binary digits may be stored.

FINISHES FOR *Aluminum* PRODUCTS



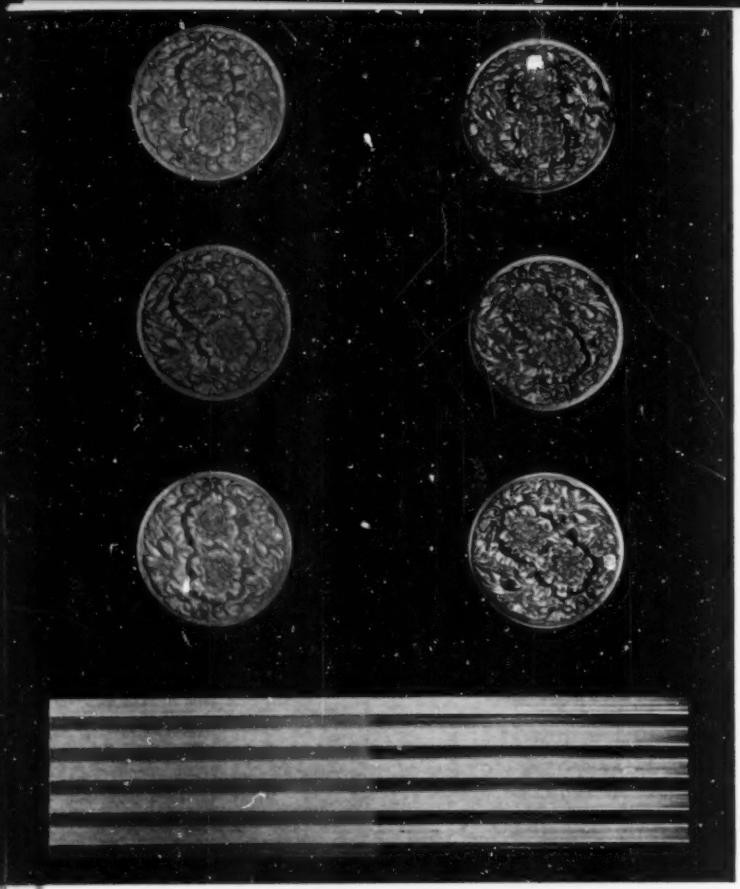
R. V. VANDEN BERG

Process Development Laboratories Aluminum Company of America

Why to specify, which pre-treatment to use for, and how to apply basic types of mechanical, chemical, electrochemical, and organic finishes on aluminum and aluminum alloys. Another in a series of full-color articles covering product improvement through better surface appearance and protection.

✦ ✦ ✦

The adaptability of aluminum to a variety of finishing methods gives it an unusual position among metals. Some finishes can be applied mechanically by polishing, buffing, hammering, sandblasting, satin finishing, burnishing or by combinations of these methods. Others can be applied by chemical or electrochemical processes that produce coatings suitable for decorative and protective applications, or both. Various electropolished and synthetic systems of finishes can also be applied to aluminum alloys, and for many applications, such finishes can be used in combination with the mechanical, chemical and electrochemical processes.



Effect of bright acid dip on wrought aluminum products: after treatment, right; before, left. This is recommended for parts difficult to buff.

Although there has been a large amount of information published in the technical literature on some of these processes, developments in recent years have changed the picture to a considerable extent. Especially is this true in the field of electrochemical finishes, where electroplating is becoming increasingly important (See PRODUCT ENGINEERING, February 1951) and to a lesser extent in the fields of organic and chemical finishes as well.

Finishes Produced by Chemical Treatment

The important objectives of chemical treatments are

1. To improve the appearance of a product or to obtain either a bright reflecting surface, a smooth diffusing surface, or a rough diffusing surface.
2. To remove dirt, grease, annealing and heat-treating films, buffing compounds and welding flux by removing a surface layer of metal.
3. To clean without roughening or otherwise changing the surface.
4. To remove oxide or chemical coatings.
5. To produce a surface which has increased resistance to corrosion, and to provide good adhesion for paints and enamels.

The chemical finishing methods include the bright dip, frosted, diffuse reflector, deep etched and Alrok treatments. The bright dip finish is a recent development that is produced by immersing the part in an acid mixture at elevated temperatures. (Alcoa R5 Bright Dip Process). It can be used instead of buffing or polishing to obtain bright finishes on a variety of aluminum alloy products, including most wrought aluminum alloys. In general, it is not recommended for casting alloys having a high silicon content, although good results have been obtained on certain other casting alloys. The bright dip treatment is particularly effective over embossed or patterned surfaces, since such surfaces are ordinarily difficult to buff without destroying the design. Also, the subsequent removal of residual buffing compound is difficult because of crevices in the embossed patterns.

A frosted finish for aluminum alloys is used on small and intricate items or large flat surfaces not adapted to machine methods of finishing. The frosted or matte effect results from an etching action in hot caustic soda. Since a surface of this type will fingerprint or stain rather easily, a coat of transparent lacquer should be applied over it. The frosted finish also is used with anodized finishes for refrigerator parts and trim.

Other alkaline solutions may be used to obtain less attack and, consequently, a smoother finish. These solutions are generally mixtures of soda ash and tri-sodium phosphate, and are used at 150 to 180 F. Their effect is to remove a limited amount of grease or oily film and produce a slightly etched surface such as desired for aluminum reflectors of the diffusing type. This surface must have both good diffusing qualities and high reflectivity.

Alkaline solutions can also be used for cleaning aluminum surfaces; a typical solution consists of 1 oz of sodium disilicate to one gallon of 3 percent soda ash-sodium tri-phosphate solution. Another satisfactory method of cleaning is by cathodic action in dilute solutions of caustic soda or sodium silicate. However, cleaners containing silicates should not be used prior to anodizing or Alrok treatments unless they are followed by a dip in strong nitric acid to remove the film formed by the silicate.

Although alkaline solutions will accomplish many of the objectives in surface conditioning aluminum products, there are other applications where a treatment in acid solutions is more desirable. Acid treatments may be used to produce

a variety of frosted or matte finishes on aluminum alloys. They are also used to remove undesirable annealing or heat treating film, buffing composition, and welding flux from the surface. Generally, these acid solutions are mixtures of nitric acid and hydrofluoric acid. If the solutions are heated, the etching action is increased, but the problem of finding suitable containers becomes serious as the temperature is increased.

Another use of nitric and hydrofluoric acid is to prepare certain aluminum alloys, such as Alclad 24S, for spot welding. An effective solution for removing annealing and heat-treating stains from aluminum surfaces consists of 10 percent by volume of sulphuric acid and 3 percent by weight of chromic acid. With this solution, which is used at from 160 to 180 F, little etching attack takes place.

Extensive use is being made of etching in the manufacture of aluminum name plates, dials, and other product identification forms. The areas that are to be protected from the etching solution must first be covered with a "resist". To form the resist, the desired design is applied to the aluminum surface by printing or silk screen engraving. Generally, etching solutions contain hydrochloric acid in amounts up to 25 percent. To obtain smoother etches, the hydrochloric acid should be saturated with sodium chloride. After the surface is etched to the desired depth, the "resist" is removed with toluol and, if desired, the background is colored with a black nickel, anodized, or enameled finish, or with a colored ink.

One series of chemical finishes for aluminum alloys is identified by the trademark Alrok. This treatment produces a surface finish less resistant to abrasion and corrosion than the electrochemical finishes, and although the finish has little decorative value, surfaces so treated possess appreciable resistance to corrosion and serve as an excellent base for paint. This type of finish is generally lower in cost than those produced by the electrochemical processes, and is especially adapted to the bulk treatment of small parts.

Coatings differ in color and ap-

Etched and printed aluminum name plates and dials. "Resists" are applied by printing or the silk screen process, and after etching, are removed with totuol. Colors are added by printing, anodizing, or enameling.

Typical hardware items and other industrial and consumer products that now are electroplated. Aluminum can be plated as satisfactorily as other metals; the salient requirement is correct surface pre-treatment.

Electrochemical, Organic, and Ceramic Finishes for Aluminum and Aluminum Alloys

	TYPE OF FINISH	HOW PRODUCED	SURFACE PREPARATION	APPLICATION AND USE
ELECTROMECHANICAL FINISHES	ALUMILITE AND OTHER ANODIC FINISHES	In electrolytes of dilute sulphuric, chromic, anodic or boric acids aluminum parts made anodic — tank and cooling coils may be cathodes.	If appearance is a factor, the surface pretreatment is important as sulphuric and anodic coatings reproduce the texture of the surface on which it is formed. Various mechanical or chemical treatments used to obtain desired final appearance. Surfaces must always be free of grease or oil for any anodic treatment. If protection prime requisite degreasing and caustic soda etch generally used.	SULPHURIC AND ANODIC used for plain and colored coatings; Gives combination of hardness, resistance to corrosion and attractive appearance. CHROMIC ACID ANODIC—Used where max resistance to corrosion and paint adhesion is prime requisite. ORALIC AND ANODIC—Used to produce hard coatings where appearance is not a factor. BASIC AND ANODIC—Used to produce rectifying films.
	ELECTROBRIGHT	Anodic treatment in electrolyte containing high percentage of phosphoric acid.	Usually buffed and cleaned. Sometimes electrobrightening is used instead of buffing to remove irregularities or burrs, but high current densities are required and the process is expensive.	To polish a surface and remove a thin film of metal together with any contaminating substance such as oxide buffing compound, or alloy constituent. Used mostly for consumer products and specialty items.
	ALZAK	A modified electrobrightening process consisting of an anodic treatment in a fluoboric acid electrolyte.	Usually buffed and cleaned. After treatment, an Alumilite finish is applied.	Used exclusively for finishing aluminum lighting reflectors to obtain high reflectivity.
	ELECTROPLATED	Brass may be applied directly over zinc film. Cadmium applied after an initial strike from a cadmium-cyanide bath. Nickel can be applied directly but copper strike first is recommended. Chromium is usually applied over a copper-nickel undercoat when maximum adherence and best appearance is required. Hard chromium for wear resistance usually is directly over a copper underlayer. For silver, treatment in low-concentration silver cyanide baths is recommended prior to plating in the standard cyanide bath.	Recommended procedure is immersion in sodium zincate solution to obtain a thin uniform zinc film. This treatment is necessary to minimize electrolytic action between the aluminum and the electroplate. To obtain maximum adhesion, copper is applied directly over the zinc layer. Usual pre-treatment procedure reduces to the following: degrease, mild alkaline clean water rinse, acid dip in concentrated nitric acid, water rinse, zinc immersion treatment, water rinse, copper strike in Rochelle-copper bath.	To improve both appearance and protection. Die castings particularly are representative of the types of products that are plated. In many instances aluminum is chromium plated to match the appearance of mating parts. Zinc is used to prevent seizing of threaded parts; brass, to obtain a surface suitable for rubber bonding; hard chrome, to reduce friction and wear; copper, to permit soft soldering to the surface; and silver, to obtain better electrical characteristics.
ORGANIC AND CERAMIC FINISHES	LACQUER, ENAMEL OR VARNISH FINISHES	An organic finish is applied in the same manner as on other metals—by dipping or spraying. Either enamel, lacquer, varnish, or black japan finish used, depending on requirements. Synthetic resin enamels highly satisfactory, as also are colored lacquers. When a clear coating is desired, either clear cellulosic or acrylic lacquers, or clear varnishes formulated with alkyd or urea formaldehyde resins, form hard protective coatings that do not turn yellow in service.	For some applications, sandblasting or scratch brushing used to anchor paint, but only where appearance and good adhesion are not too important. Solvent cleaners, alkaline cleaners, phosphoric acid and an organic solvent, Alrok, Alumilite, anodic, Alodine, Bonderite 170, Iridite 14 and Lyfanite are used when better adherence and protection are required (see text). Zinc chromate, aluminum base, or wash coat primers then used prior to application of finish coat.	On all types of aluminum and aluminum alloy products (1) to match finishes on other components; (2) to obtain inexpensive finish; (3) to get better protection under certain atmospheric conditions; (4) to obtain special effects, such as natural metal, and protecting surface against oxidation, or (5) to desired appearance or characteristics, as for example, brilliant colors that are difficult to get with other types of finishes.
	SPECIALTY FINISHES	Wrinkle, single-tone and two-tone hammer, veiled lacquer, crystal, crackle, or flock finishes applied by special techniques.	Same as above or to manufacturer's recommendations. Buffing or polishing usually not required for wrinkle or crackle finishes.	Particularly on business machines and office equipment, laboratory equipment, and industrial machinery. Not too widely used on household equipment.
	VITREOUS ENAMEL	*Pre-fired* at 970 to 1,000 F for five minutes. *Ground coats* sprayed, dried, and fired at 940 to 1,000 F. Application weight, 15 to 20 grams per square foot. *Cover coats* sprayed and fired at 940 to 1,000 F. Application weight; 25 to 50 grams per square foot.	Surface must be free from oil, grease, anodic coatings, or any residual films from inhibited alkaline cleaners.	Sanitary ware, washing machine tubs and agitators and architectural trim.

Mechanical and Chemical Finishes for Aluminum and Aluminum Alloys

TYPE OF FINISH	HOW PRODUCED	SURFACE PREPARATION	APPLICATION AND USE
MECHANICAL FINISHES			
GRINDING	With wheels consisting of 80 to 120 emery applied to face-glued sections of muslin, canvas, or solid felt wheels. Tallow, mineral grease or lard oil should be used as a lubricant to prevent burning.	Rough grinding is the initial operation after casting or fabrication. Only previous operations are concerned with production process, as shake-out after sand casting, for example.	To remove metal from sand and permanent mold castings, fins from die castings, or burrs or edges from fabricated parts that are unusually rough.
OILING	Refinement of grinding operation using finer abrasives and softer wheels. Abrasives range from 120 to 200 mesh. Wheels are usually constructed of soft felt, and speeds of about 6,000 fpm are generally satisfactory.	Rough grinding, if required.	Usually is the initial step in polishing, since rough grinding is required only in special instances. Is being replaced by abrasive coated belts operated in conjunction with contact wheels. Speeds up to 7,000 fpm with suitable lubricants, produce excellent results.
BUFFING	With stitched rag wheel and Tripoli compound in a grease binder. Fine grain Tripoli and high wheel speeds – 7,000 to 7,500 fpm – gives surface with highest luster. Pitting and cloudiness may result from using too hard a wheel or too much pressure.	Depends entirely on the product and method of production. Usually preceded by an oiling or polishing (finish grinding) operation on all parts except those, such as die castings, having a first class finish.	To bring out high luster on the metal and remove surface scratches. Usually necessary for any part that is to be electroplated, anodized, or finished by other chemical are electrochemical processes for appearance.
COLORING	With loose or unsewed buffs operated at speeds of 7,500 to 8,000 fpm. Coloring compounds are usually a soft silica and lime composition abrasive with a grease base.	Previous buffing operation followed by a cleaning operation to remove the residual buffing compound. A light caustic etch is satisfactory for this purpose.	To impart a highly reflective, lustrous surface on such products as trim, refrigerator evaporator doors, gift ware, cooking utensils and reflectors.
SATIN FINISH	With a fine wire wheel, scratch brush, tampico brush, greaseless satin compounds, an air abrasive blast, or a liquid abrasive blast.	An initial oiling or polishing treatment may be necessary to remove defects that otherwise might show through the finely scratched lines on the surface.	To obtain a soft, smooth sheen on a surface by scratching fine parallel lines with it. Widely used for decorative effect on consumer products or architectural trim.
SAND AND VAPOR BLASTING	With sand and a high pressure air stream or with a mixture of fine grain abrasives and water. Alumina and silicon carbide abrasives used to obtain certain colorations.	Deep serrations and blemishes must be removed by polishing or buffing. Often anodized finishes are applied over the blasted surface, or buffing and grinding are used to obtain highlighted effects.	To get a uniform matte surface finish on parts for home appliances or on decorative trim. Vapor blasting also used to remove dirt and oxide films from a surface.
HAMMERED OR PEENED FINISH	Manually or by shot peening. Can be done after covering surface with soot to obtain wrought iron effect.	Usually done on buffed surface. Afterwards, can be hand rubbed with steel wool to get highlights.	To obtain an irregular pattern on the surface of a part. Mainly used for giftware and architectural trim.
CHEMICAL FINISHES			
BRIGHT DIP	Immersion in a acid solution held at a temperature of about 180 to 200 F.	Usually on unbuffed parts, and is particularly effective on embossed or patterned surfaces that would be difficult to buff uniformly and difficult to clean after buffing.	For most wrought alloys and some cast alloys having a low silicon content. Gives a bright finish that is similar to a buffed finish at a much lower cost.
FROSTED AND ETCHED FINISH	Frosted usually produced by an etch in hot caustic soda; smoother etch, in soda-ash and tri-sodium phosphate. Acid treatments also used to obtain less drastic etch.	Caustic or acid etch is usually first treatment. Often used to clean surface of heat-treating film, buffing compound or other films prior to final finishing or welding.	To get uniform matte effect for decoration on consumer products, diffusing surface on light reflectors, to clean the surface prior to anodizing, or to obtain contrasts and design in nameplates.
ALROK FINISHES	A series of finishes produced by forming an oxide-coat by means of chemical solutions, such as hot sodium carbonate and sodium dichromate.	Generally over degreased surface or over etched surface. After treatment, coatings are sealed in dichromate if maximum protection is desired; Alrok coatings may also be dyed, but lack depth of color.	As a base coat for organic finishes; gives fairly good protection to abrasion and corrosion. Suitable for small bulk parts where higher cost of electrochemical finishes are not justified.
BONDERITE 170, ALODINE, IRIDITE 14, AND LYFANITE	Immersion or spray.	Over degreased or etched surfaces.	Almost exclusively as base for paint. See organic finishes.

pearance, depending upon the process used and aluminum alloy coated. The color of the finish, which is applied in an alkaline solution, ranges from grey to greenish grey depending on the concentration and length of exposure. A sealing treatment may change this color to a yellowish green. Generally, the coatings have a glossy appearance, but they will be dull if the surface has been previously etched; and although some of the coatings can be dyed, they lack the depth of color obtainable with most anodic coatings.

For greatest resistance to corrosion and as a base for paint, Alrok 12 and 14 are used. Unpainted Al7S-T4 rivets treated by the Alrok 14 process will pass the salt spray test of 250 hours required by the federal specification for anodic coatings. Type 24S-T4 rivets similarly treated will also meet this specification.

Electrochemical Finishes and Treatments

Practical commercial methods are now available for electroplating aluminum and its alloys. Numerous surface preparation procedures have been worked on for over twenty-five years. These methods include the following:

1. Deposition over a surface roughened by chemical etching.
2. Anodic oxidation of the surface and modification of the film to "key" the deposit.
3. Chemical oxidation of the surface as a surface preparation.
4. Various heat treatments to improve adhesion with above methods.
5. Surface pre-treatment by the zinc immersion process to produce a zinc film.

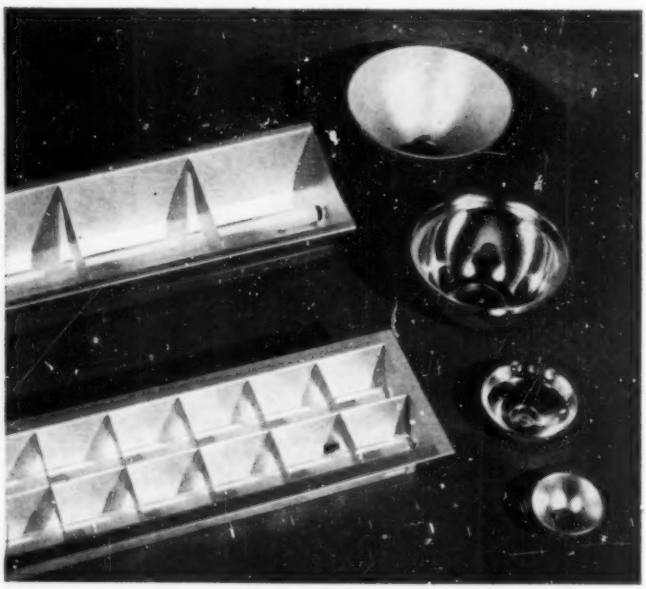
Of all these methods, the zinc immersion process is considered the most satisfactory and practicable. Generally, the other methods are too complicated and the conditions too critical for commercial use.

In this process, the part is immersed in a solution of sodium zincate and caustic soda, which forms a thin zinc film on the surface. The deposition is self-arresting, depending on the concentration and temperature of the bath, so that the thickness of the film can be controlled by regulation of the bath. To obtain maximum adhesion of the final electroplate, a copper strike should be made over the zinc layer, using a Rochelle-cyanide solution. Inasmuch as the zinc film is extremely thin, precautions must be observed to prevent the copper strike from dissolving it; both a low pH value and low temperature are recommended for the bath.

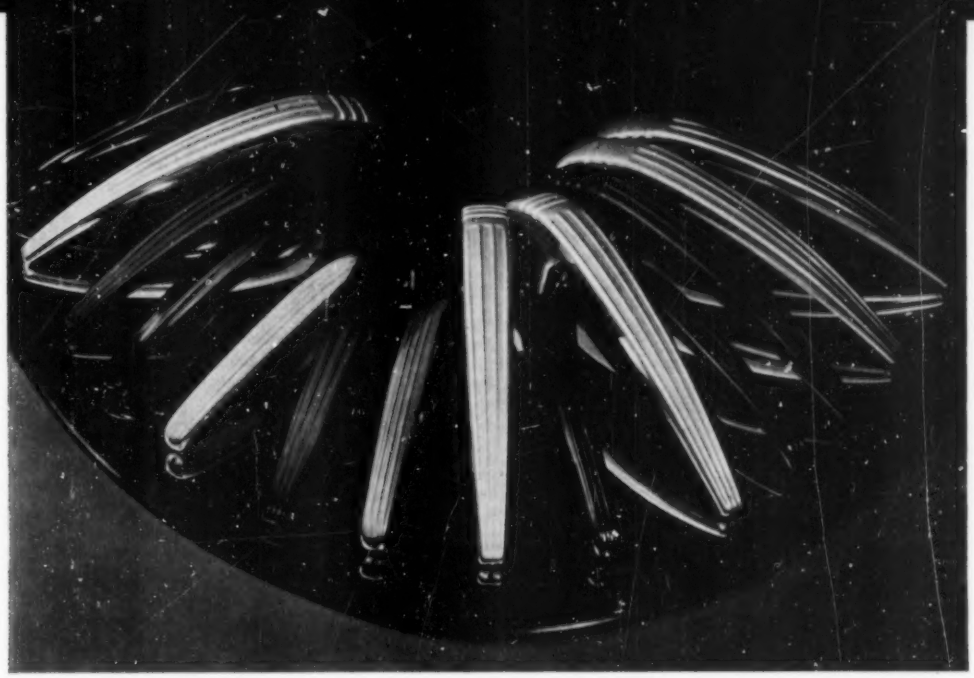
Once the copper strike layer has been applied, other metals such as nickel, brass, silver, zinc, cadmium, hard chrome and tin may be applied. If smooth, heavy layers of copper are desired, the copper deposition can be continued in a high speed bath.

Brass, cadmium, nickel, chromium and silver may be applied directly over the zinc immersion layer. Generally, a brass solution is used at room temperature or slightly above. Its pH is usually low enough so that no chemical attack on the zinc film will take place. Cadmium is applied successfully if a strike from a modified cadmium cyanide bath is applied first. This bath is a diluted version of the standard cyanide bath. Nickel has been applied directly over the zinc layer, but conditions are critical, and this procedure does not produce uniform adhesion. Chromium also has been applied directly over the zinc layer, but it involves the use of a room temperature bath followed by deposition in a high temperature bath to obtain the desired thickness. Excellent results have been obtained with heavy hard chrome deposits obtained by plating in a high temperature bath over the copper deposit from the Rochelle-copper-cyanide strike solution. If silver is applied directly over zinc, the use of two low-concentration silver cyanide baths is recommended before plating in the standard cyanide bath.

Other popular and useful electrochemical finishes for aluminum alloys are the so-called anodic finishes, one patented process being the Alumilite finish. By making aluminum or its alloys the anode in a suitable electrolyte under controlled conditions of voltage, current density and temperature, a surface coating is formed which is essentially aluminum oxide. This oxide coating is the result of electrochemical oxidation of the aluminum sur-



Diffuse and spectral Alzak finishes on lighting fixtures. Besides high reflectivity, this finish provides excellent atmospheric protection.



Handles finished by the Alumilite process. The luster of the underlying metal gives these colors a metallic sheen.

face, and cannot be peeled or chipped from the surface. Generally, any chemical which attacks the coating will also attack the underlying aluminum. A solution composed of chromic and phosphoric acids, however, will dissolve the coating with no attack on the base metal.

The anodic process is applicable to all aluminum alloys, but the structure and color of the resulting oxide film will vary with alloy and temper. Anodic coatings on high purity aluminum are continuous and transparent. Silicon is particularly detrimental, causing the coating to change from brown to a grey gun-metal color. Since many aluminum alloy castings contain varying amounts of silicon, the coatings on castings are rather dark in color.

This type of coating as formed has a cellular structure composed of walls of oxide surrounding the pores or groups of pores. That portion of the oxide nearest the outer surface is sponge-like in form because of a slight solvent action of the electrolyte. This structure and the mordanting action of the film are valuable characteristics that can be used to advantage in coloring the coating by means of water soluble dye stuffs or pigments. The colors produced are unique, as the luster of the underlying metal gives them a metallic sheen that is very attractive.

The finish reproduces the texture of the surface on which it is formed. If it is desired to maintain the silvery metallic appearance, a sealing treatment is used to close the pores and make the coating stain-resistant. When protection is the main consideration, special sealing techniques are used to absorb corrosion inhibitors into the coating. Such a system is employed when the coating is used as a base for protective paints or enamels.

By variations in the procedure, coatings with a variety of hardness may be produced. These hard coatings will give excellent resistance to rubbing wear. For this reason, the finish is used on aluminum alloy automotive pistons to resist "cold scuffing".

Because aluminum oxide is a good dielectric, these coatings have sometimes been used as an insulating medium. An oxide coating of 0.0005 in. thickness may have a voltage breakdown value as high as 600 volts. Unfortunately, however, the minimum breakdown voltage may be 200 to 300 because of weak spots in the coating. Another desirable characteristic of the finish when used as an insulation medium is its stability when heated. It does not char or give off a gas as do organic insulating materials. The cost of application, however, is one factor which limits its use.

Any anodic finish gives substantial protection against the weather, and for this reason is used extensively in the architectural field. Films having a thickness of 0.4 mil are generally used for surfaces having routine maintenance. However, for maximum resistance to corrosion and weathering, films having a thickness of 0.8 mil are recommended. There are a large number of applications where films of less than 0.4 mil thickness are being used with excellent results. For applications where appearance or brightness is the important consideration, thinner coatings are applied. There are a variety of special anodic treatments employing various electrolytes which produce coatings with extreme hardness and resistance to corrosion, as well as providing "valve", or rectifier, effects.

Several anodic treatments for aluminum and its alloys, known as "Electrobright" processes, are used to obtain the maximum in surface

brightness. These processes remove a thin surface film of metal together with any contaminating substances such as oxide, buffing compound, or alloy constituent. There is also a tendency for electrolytic brightening treatments to smooth the surface. But deep scratches, or pits are not removed and the processes are no substitute for buffing in this respect. Some Electrobright treatments will remove burrs and other minor irregularities from the surface, but such treatments require high anodic current densities and are somewhat more expensive to operate.

The best known commercial application of electrobrightening is the Alzak process, which consists of an anodic treatment in a fluoboric acid electrolyte and is used for finishing aluminum lighting reflectors. An anodic finish is then applied to protect the surface of aluminum reflectors. Reflectors made by this process are characterized by a combination of permanence and high reflectivity.

Organic and Ceramic Finishes

In recent years, the increased use of aluminum and its alloys in the building and transportation fields has resulted in numerous applications of paint, enamel or lacquer finishes. In many cases, the use of paint and enamel is the most economical finishing system, while in other cases its use is desirable from the standpoint of protection or decoration. Aluminum alloys are not difficult to paint, and if the proper surface pre-treatments are employed, adhesion is as good as or better than with other metals.

Methods for treating aluminum surfaces for painting are generally divided into three classes, namely (1) mechanical, (2) solvent, and (3) chemical or electrochemical. Mechanical methods involve roughening the surface by sandblasting, scratch brushing or hand sanding. Surface roughening is ordinarily not required to obtain good paint adhesion but is used for special service conditions. If these procedures are employed, it is necessary, of course, to use a preliminary treatment to remove all grease and dirt from the surface.

Solvent cleaning methods include vapor degreasing, solvent immersion or hand cleaning with high flash point petroleum solvents. Care must be taken that no residual films remain on the surface after solvent cleaning. Heating the surface after cleaning will remove these films.

Solvent cleaning and its variations will be adequate for some applications; but for severe service conditions, chemical or electrochemical treatments are more effective. Inhibited alkaline cleaners may be used to remove limited amounts of grease from the surface, provided that after rinsing the surface is given a dip in a dilute solution of chromic or phosphoric acids.

Another method, using water solutions of phosphoric acid with additions of alcohol or other organic solvents, wetting agents and emulsifying agents, gives excellent results. These solutions may be applied by brushing, swabbing or tank immersion. After thorough rinsing with clear water, the surface should be dried and painted as soon as possible to avoid contamination.

For severe service conditions, certain chemical or electrochemical treatments provide the best surface preparation for organic finishes. These processes include the Alrok and Alumilite and chromic acid anodic treatments. Other proprietary treatments such as Alodine, Bonderite 170, Iridite 14 and Lyfanite are also effective treatments for this application.

As in the case of other metals, there are several different primers which may be used on aluminum surfaces. Selection of the proper primer depends upon the service conditions. Under some conditions, the primer must have a combination of good adhesion and corrosion-inhibiting properties. In other cases, good adhesion is the prime requisite. On surfaces that are exposed to corrosive conditions, primers containing zinc chromate are generally used. These primers may have an alkyd or phenolic resin base, or a mixture of both. Lead pigmented primers should not be used on aluminum because of the danger of galvanic corrosion.

With the recent introduction of the so-called "wash coat primers," chemical pretreatment is generally not required—the surface is treated at the same time it is being primed. These "wash coat primers" consist of a polyvinyl butyral vehicle lightly pigmented with basic zinc chromate. Just prior to application, a solvent solution of phosphoric acid is added. The primer is applied by conventional methods. This system is generally recommended for priming assembled parts when there is danger of acid entrapment in crevices. If any acid is retained in crevices, it may cause breakdown of the paint films.

After priming, an organic finish is applied in the same manner as on other metals—usually by spraying or dipping. An enamel, lacquer, varnish, or black japan finish may be selected, the base and vehicle depending on requirements.

One precaution must be observed in the choice of finishing systems employing high temperature bakes (over 300 F) on heat-treatable alloys such as 17S or 24S. Heating to these temperatures causes metallurgical changes in the alloy that result in lowered mechanical properties and resistance to corrosion.

Ceramic coatings may also be applied to aluminum alloys. Recent developments in low melting point vitreous enamels has resulted in coatings which have superior impact and flex resistance and good resistance to thermal shock. Unlike steel, vitreous enamel coated aluminum will not show rust spots if chipping should occur. Enameled aluminum can be cut and mildly formed after firing. As the vitreous enamels are fused at a fairly high temperature, care must be taken in the selection of alloy, gage and temper to minimize such effects as excessive distortion and softening of the base metal. These new ceramic coatings are resistant to mild acid and they are obtainable in a range of colors.

Mechanical Finishes

Techniques for applying mechanical finishes on aluminum alloys are quite conventional. There are some differences in practice, however, that are necessitated by the physical properties of aluminum alloys. Salient details are given in the table on the preceding pages.

Not, PLEASE, In the Name of Fairness

Our national Office of Economic Stabilization has adopted a policy of gearing wages to the cost of living. We are told that "escalator clauses," which provide that rates of pay shall be adjusted to take account of changes in the cost of living, will be generally approved.

If the adoption of this policy had been announced as a frank concession to political expediency, it would have been quite understandable. There may very well be votes, lots of them, in a policy which purports to protect the income of a large group against loss through the price inflation caused by the defense program.

A case might even have been made for a policy of approving escalator clauses on grounds of production expediency. The leaders of some three million organized workers now covered by such clauses have indicated that they would fight to the limit to keep them and thus maintain "real wages," that is, wages measured by their purchasing power. The leaders of other organized groups have indicated they would fight to get the benefit of such clauses. Denial of them might mean serious strikes.

Justified "in Fairness"

However, the policy of approving escalator clauses was not based on these relatively low grounds of expediency. It was justified on high moral grounds, on grounds of "fairness." In the words of the President's Council of Economic Advisers, "maintenance of real wages during inflation cannot in fairness be disallowed."

That proposition is false.

It would be truthful to say, "maintenance of real wages during inflation cannot in fairness be allowed."

The truth of the corrected proposition becomes evident immediately when you take a look at the basic nature of the inflationary problem created by defense mobilization.

We are devoting a large share of our national production to defense. The share is now scheduled to hit about 20% in 1952.

Since we are not able to increase our total production fast enough to meet defense needs

in addition to civilian needs, that means a cut in the supply of goods and services that is available for civilian consumption. But the money paid out for the production of defense materials is added to that which is available to buy civilian goods.

Thus, more money is put into the hands of the people to buy less goods. So prices go up. That is inflation.

If one group of people then is granted enough additional money to offset the price increases — and that is the purpose of an escalator clause — and thus can continue to buy as much as they have been buying right along, less goods will be left for other consumers who are not getting this advantage. That is palpably an unfair distribution of the sacrifices necessitated by defense mobilization. In fairness, therefore, maintenance of real wages in inflation cannot be allowed.

Organized workers were not the first, of course, to get the benefit of an automatic adjustment to take account of the increased cost of living. The farmers got theirs first. The price parity formula is, in essence, an escalator clause. The federal government underwrites increases in the prices of the things farmers sell in order to match increases in the prices of the things they buy.

Crucifying the Helpless

As matters stand, two groups are without benefit of escalator clauses. One group is composed of manufacturing firms. While they have not been nearly as successful as the misleading reports of "record-breaking profits" suggest, they have been able to look after themselves fairly well — thus far.

But one group is completely without protection. It is that numerically large but politically unorganized mass of people — many of them old and relatively helpless — who are trying to live on pensions, annuities and other fixed incomes derived from their savings. They are at the end of the line when the increased costs of inflation are passed along. They have no one to whom they can pass the buck. They are being progressively pauperized by the continuing inflation caused by progressive boosting of costs and hence prices.

With the present line-up of pressure groups in Washington, protection for the principal victims of inflation — those who have saved for a rainy day only to find inflation has blown away the roof — is obviously an extremely difficult business. But to have even temporary insulation against inflation granted to powerful groups in the name of fairness should be offensive to the nostrils of a nation that presumes to assert the moral leadership of the Western World.

The only really fair way to handle inflation is to prevent it. But once it is under way, fairness demands that the burdens be as evenly distributed as practicable.

An escalator clause — or a farm parity provision — is explicitly a device to enable the group favored by it to escape the burden of inflation. Whatever concessions we feel we must make to political pressures or production expediency, let us at least be honest enough not to invoke "fairness" as justification for so arbitrary a discrimination in the distribution of the defense burden.

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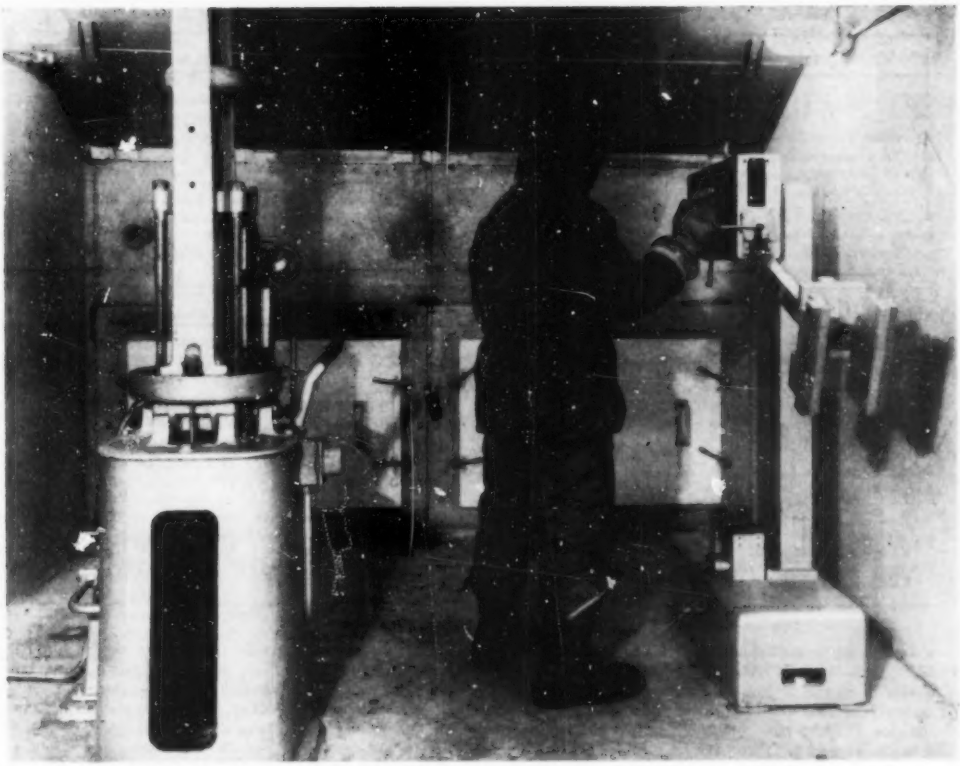

Impact and tensile testing equipment are installed in a cold chamber for low temperature testing of aircraft metals.

Effect of Low Temperatures on Aircraft Metals

J. B. JOHNSON[1] and D. A. SHINN[2]

THE INCREASED CEILINGS of aircraft and missiles and the establishment of military bases in Arctic regions have stimulated the investigation of the effects of subzero temperatures on metals used in aircraft. These effects are indicated by changes in physical and mechanical properties. They concern not only the physicist and metallurgist but also the designer and fabricator, since they influence the allowable stress levels used in design, the dimensions of mating parts, the timing of forming operations of metal components and the rate and amount of hardening.

Air-borne vehicles, particularly for military service, must be designed and constructed to operate under any climatic conditions encountered on the earth's surface and above it to the absolute ceiling of the aircraft or missile. Due to the difficulty of maintaining and servicing aircraft at low temperatures, —80 F is the lowest ground level temperature which need be considered. Actually the standard requirement of the Air Force of —65 F is more realistic. Between 50 and 60 thousand ft. the low limit of ambient air temperature approaches —130 F. However, due to aerodynamic heating and thermal gradients within the aircraft structure it is highly improbable that the structure reaches this temperature.

The embrittling effect of subzero temperatures on metals requires careful consideration in the design of structural parts. Although no new design factors are involved, there exists

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Presented at the 1951 Metallurgical Conference, National Bureau of Standards, Washington, D. C.

Table I—Chemical Composition and Heat Treatment of Representative Aircraft Metals

NONFERROUS

Metal	Specification	Composition, percent									
		Si	Fe	Cu	Mn	Al	Mg	Zn	Cr	Ni	Other
24S-T4 Aluminum[1]	QQ-A-354	0.16	0.43	3.8-4.4	0.6-0.9	bal.	1.2-1.7	0.10	....	0.05	0.05 Bi Pb
75S-T6 Aluminum[1]	AN-A-9a	0.20	0.45	1.50	0.15	bal.	2.80	5.70	0.80	.....	0.05 Ti
FS-1h Magnesium[2]	AN-M-27	0.01	0.001	0.01	0.49	3.10	bal.	1.05	....	0.001	
Titanium[3]	.....	Commercially pure from Remington Arms									

[1] Commercially heat treated and aged, 3/4 in. round bars.
[2] Extruded and cold drawn 3/4 in. round bars.
[3] Received in hot swaged condition as 5/8 in. rounds with Vickers hardness number of 250.

FERROUS

Steel	Specification	Composition, percent									
		C	Mn	P	S	Si	Ni	Cr	Mo	Al	Ti
SAE 2330[4]	AN-QQ-S-589	0.28-0.33	0.60-0.80	0.026	0.030	0.20-0.35	3.25-3.75	....	....	....	....
NE(SAE) 8630[5]	Am-S-14a	0.27-0.33	0.70-0.90	0.022	0.033	0.20-0.35	0.48-0.67	0.49-0.56	0.18	....	....
Type 304 Stainless Steel (18-8)[3]	.....	0.054	0.49	0.019	0.015	0.42	8.82	18.50	....	....	....
Hy-Tuf[4]	.....	0.259	1.26	0.016	0.017	1.37	1.91	0.09	0.43	....	....
SAE 4340[5]	AN-QQ-S-756A	0.46	0.70	0.018	0.031	0.288	1.78	0.95	0.23	....	....

[1] Received as normalized. Austenitized at 1,500 F, oil quenched and tempered at 925 F to 150,000 psi tensile strength.
[2] Received as normalized. Austenitized at 1,500 F, oil quenched and tempered at 850 F to 150,000 psi tensile strength.
[3] Cold drawn to 210,000 psi tensile strength.
[4] Received as normalized. Austenitized at 1,575 F, oil quenched and tempered at 550 F to 230,000 psi T.S.
[5] Received as normalized. Austenitized at 1,550 F, oil quenched and tempered at (a) 1,200 F (150,000 psi T.S.) and (b) 800 F (230,000 psi T.S.)

a definite influence on the degree of effect these factors have on the behavior of metals at low temperatures. A study of test results showing the changes in properties of the metals listed in Table I with temperature will give the design engineer a picture of what can be expected from a metal and what design changes may be necessary.

Factors Influencing Design

The mechanical properties of the metals used in aircraft construction are obtained by uni-axial static tests of specimens at approximately 70 Fahrenheit. At lower temperatures the ultimate and yields strengths and the modulus of elasticity invariably increase as shown in Fig. 1 and Table II. These higher values assure an increase in the positive margin of safety with uni-axial static loading.

For the type of loading which produces combined (poly-axial) static or cyclic stress there is required a certain amount of ductility or ability of the metal to flow or change dimension permanently before fracture. Ordinarily, parts are not designed to change shape permanently in service, but invariably many of them do, at least locally. The examination of any airframe structure will reveal elongated rivet and bolt holes and slightly distorted parts which have been forced into alignment or deformed by one or more applications of load above the elastic range. Innumerable fillets, notches and welds act as foci for poly-axial stresses.

Ductility is generally evaluated by the elongation and reduction of area

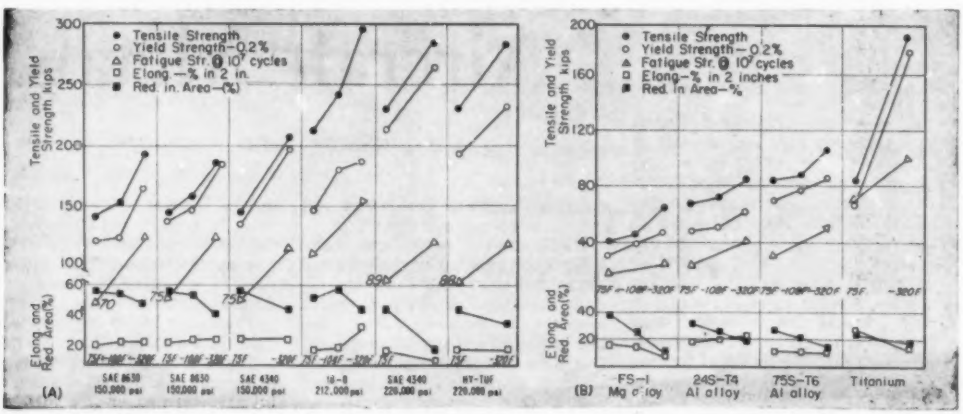


Fig. 1—(A) Tensile and fatigue properties of ferrous metals from —320 F to room temperature. (B) Tensile and fatigue properties of non-ferrous metals from —320 F to room temperature.

in a tensile specimen, the distortion and local increase in area of a compression specimen; the angle of twist or number of reversals in a torsion test; the number of reversed bends or the angle of bend in a transverse test; and the foot pounds of energy absorbed in an impact test by notched and unnotched specimens. These criteria may not measure exactly the same phenomena since variations in structure, strength and shape of the test piece will affect the ratings. The values obtained by making tests at approximately 70 F are used for the preparation of specifications.

The selection of the minimum values of ductility for acceptance or rejection of material is seldom based on design considerations, but rather on the control of quality and uniformity, and in some cases, formability and machinability. If the stress level is 200,000 psi for steel, the accepted elongation may be as low as 6 percent, but for a stress level of 100,000 psi, the minimum accepted elongation may be as high as 25 percent. In castings over a wide range of stress levels, 1 to 3 percent is accepted. Acceptance of these values by engineers is based on successful application under operating conditions, i. e., experience. For example, the necessity for a reasonable level of center ductility in forgings for gas turbines was not definitely established until wheel fractured occured in service, although there was much prior discussion both pro and con.

The ductility of metals changes with a decrease in temperature below 70 F, although the amount varies with the method of measurement. If these changes are used to evaluate metals for engineering applications, the basis of evaluation should be their effect on the performance in service. The reduction of area decreases with lower temperatures for all metals investigated, but not appreciably above —108 F. In fact, the 18 chromium —8 nickel stainless steel has a slightly higher value. It is probable that the slope of the lines connecting the points for SAE 4340 steel are too steep to — 108 F, since the steel with lower nickel content, SAE 8630 shows little change in ductility. The magnesium alloy, *FS*-1, shows the largest decrease, but no effects of low temperature have been noticed in its serviceability for rather extensive applications in the skin and structure of the B-36 high altitude bomber. Ductility, as measured by elongation over a length four times the diameter, changes very little for any of these metals down to minus 108 Fahrenheit.

Tensile, Impact and Fatigue Effects

In the design of metal components for low temperature service the effects of size and shape, strain rates and stress distribution on the transition from ductile to brittle behavior must be considered. Sensitivity to these factors is usually obtained by tensile, impact and fatigue tests using notched and unnotched test specimens.

The tensile strengths of notched and unnotched specimens of aluminum and magnesium alloys indicate little effect of the notch at either room temperature or —320 F (Fig. 2). A standard tensile specimen with a circumferential, 60 deg. *V* notch with root radius of 0.010 in. and a constant depth of 0.025 in. was used. A notch with a larger root radius would have given an increase in strength.

In the cases of titanium and steel, except for SAE 4340 at 220,000 psi where residual stresses may mask the effect, there is an appreciable increase in strength at both temperature levels due to the notch.

The reduction of area at the root of the notch, Table III, is a sensitive indicator of temperature effects and rates the materials in practically the same

Table II—Low Temperature Modulus of Elasticity in Tension of Representative Aircraft Metals

Material	Modulus of Elasticity (E x 10^6 psi)			
	−25 C −77 F	−78 C −108 F	−196 C −320 F	Increase% +25 C −196°C
Aluminum Alloy, 24S–T4	10 87	11 11	11 97	10 1
Aluminum Alloy, 75S–T6	10 27	10 75	11 55	12 4
Magnesium Alloy, FS–1	6 36	6 83	7 30	14 7
Titanium, Commercially Pure	16 7	17 5	18 96	11 3
Steel, SAE–2330 (150,000 psi)	29 18	.....	31 59	8 3
Steel, SAE–8630 (150,000 psi)	29 77	.....	32 38	8 8
Steel, SAE–4340 (150,000 psi)	30 9	.....	31 8	2 9
Steel, SAE–4340 (230,000 psi)	30 7	.....	30 9	0 6
Steel, SAE (High Temp.) (230,000 psi)	29 8	.....	31 3	$ 0
Steel, SAE–18 8 (210,000 psi)	23 57	.....	27 66	17 5

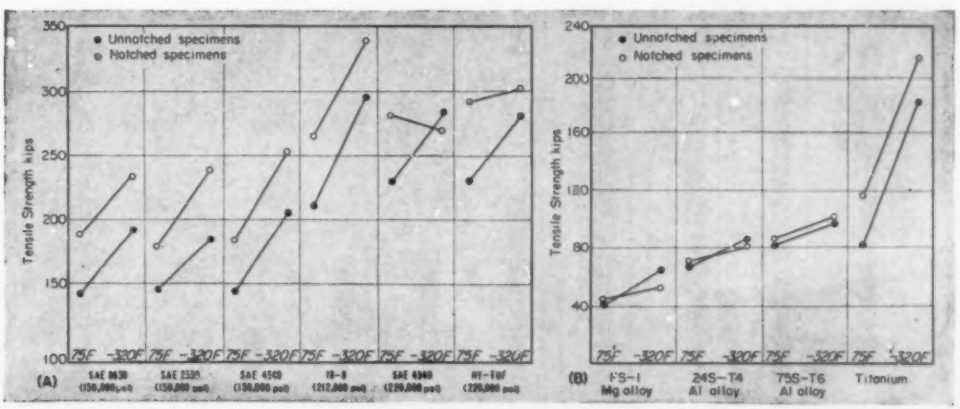


Fig. 2—(A) Tensile strengths of notched and unnotched ferrous specimens at —320 F and room temperatures. (B) Tensile strengths of notched and unnotched non-ferrous specimens at —320 F and room temperature.

Table III—Effect of Temperature on Ductility Factors of Representative Aircraft Metals

Material	Notched Static Tensile			Charpy Impact		
	Reduction of Area at Root of Notch, percent		Temperature Effect, percent	Ft. lb of Energy		Temperature Effect, percent
	Room	−320 F		Room	−320 F	
75S-T6	2.25	2.25	0	4	6	+50
24S-T4	7	6.5	−7	5.5	6	+10
18-8 Stainless	11.5	7.25	−37	24.7	30.3	−25
Titanium	12.5	5.0	−60	14.5	6.6	−54
FS-1b	11.25	4.0	−65	4.2	2.0	−52
SAE 2330 (150,000 psi)	22	6.75	−70	35.3	16.8	−50
SAE 4340 (150,000 psi)	17	6.25	−61	38.7	16.4	−57
SAE 4340 (230,000 psi)	3.5	2.75	−21	19	7.4	−60
Hy-Tuf (230 000 psi)	7.5	2.5	−66	24.8	9.7	−60
SAE 8630 (150,000 psi)	13.25	3.25	−75	39.1	5.0	−87

order as the notched impact test. When the ductility is low at room temperature as in the case of SAE 4340, the percentage loss in ductility is much less than when the room temperature value is high.

Investigations have shown that for ferrous metals the transition from ductile to brittle fracture is dependent on the type of test. The change occurs at a higher temperature for notched impact than for tension or torsion specimens. Increasing the sharpness of the notch increases the severity of the test. In Fig. 3 is shown the effect of reduction in temperature on the notched bar impact values for several aircraft metals.

The relationship between chemical composition, structure, and mechanical properties of materials such as steel, magnesium and plastics is not sufficiently well understood to compare them on the basis of notched impact tests. For similar compositions, the impact values indicated the tendency to fail with more or less plastic deformation under the rather complicated stress pattern at the root of the notch. The correlation of impact tests on standard specimens with tests on larger machine components or structures is not too satisfactory, with the exception of ballistic tests on armor plate and tear tests on ship plate.

Izod notched bar tests and Stanton impact tests were used extensively at one time for measuring the quality of aircraft engine forgings. The practice was discouraged because of the following: lack of correlation of test results with serviceability; the low values obtained with specimens cut from highly stressed portions of parts where grain flow was not perpendicular to the plane of the notch. The reduction in impact values due to decrease in temperature are of the same order as those due to grain orientation at room temperature.

As previously noted in Fig. 2, the fatigue strength of unnotched specimens at 10^7 cycles increases without exception as the temperature is lowered. In most cases the fatigue strength increases a little faster in percentage than does the ultimate, but for the magnesium and titanium materials which have a close packed hexagonal atom arrangement, the increases in ultimate strength are 57 and 108 percent, respectively, whereas the fatigue strength increases only 47 and 37 percent. No explanation is offered except that such a behavior may be due to the different structure of these two materials as compared to the others.

The effect of temperature on the fatigue strength of unnotched specimens at three different lifetimes, Fig. 4, indicates that magnesium alloy and titanium react differently to temperature than do any of the other materials, with the possible exception of 18-8 stainless steel. For these materials a decrease in temperature results in a larger gain in fatigue strength as the lifetime is reduced, whereas for the remainder of the materials the reverse is true. For example, the fatigue strength of the magnesium alloy (*FS-1*) is increased for low temperature only 30 percent at 10^7 cycles but is increased 50 percent at 10^4 cycles. This condition might be expected since the static strength is more rapidly increased by decreasing the temperature and 10^4 cycles is nearer the static $\frac{1}{2}$ cycle test than is 10^7 cycles. To take an extreme example of the reverse situation; the fatigue strength of the Hy-Tuf steel (220,000 psi) increases at low temperature about 35 percent at 10^7 cycles, but the change at 10^4

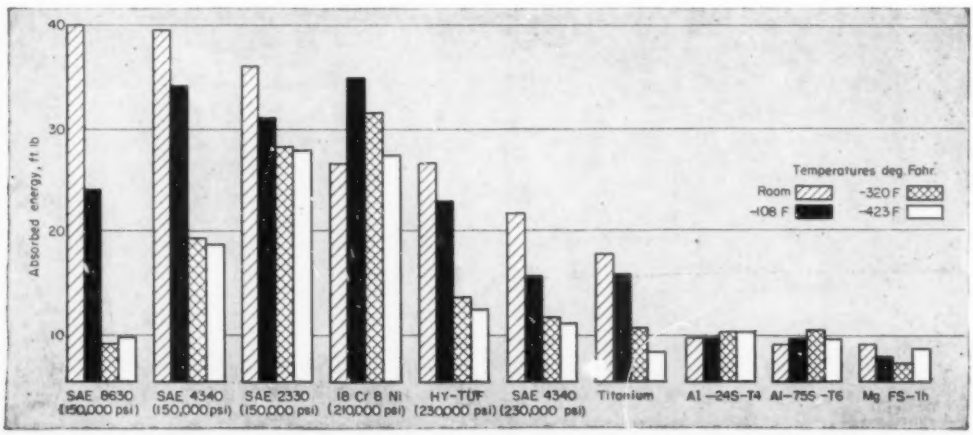


Fig. 3—Charpy impact results on representative aircraft metals at −420 F, −320 F, −108 F, and room temperature.

cycles is slightly negative. This phenomena might be important in those designs where high allowable cyclic stresses are encountered.

For notched specimens, Fig. 5, several points of interest are noted, the first of which is the high percentage increases in fatigue strength at 10^7 cycles at —320 F for 24S-T4 aluminum alloy and 18-8 steel. These increases are even higher than for unnotched specimens. Otherwise, increases were less for the notched specimens than for unnotched specimens, with the exception of titanium which reacted similarly, notched and unnotched.

In several cases, notably for the heat treated steels, notching caused a decrease in fatigue strength large enough to be considered in designs for applications at very low temperatures—below those of significance in the operation of aircraft.

The same general trend as noted for unnotched specimens relative to effect at low temperatures at various numbers of cycles was observed for notched specimens. The magnesium alloy and titanium in this case followed the trend of the other materials of having their fatigue curves start close together and diverge as the number of cycles increased.

The relation of the experimentally determined fatigue stress concentration factors to the theoretical factor calculated by Neuber's method and formula is shown in Fig. 6. This formula is as follows:

$$\frac{K_f - 1}{K_t - 1} = q$$

where K_f = $\dfrac{\text{fatigue strength (unnotched)}}{\text{fatigue strength (notched)}}$

K_t = theoretical stress concentration factor

The three sizes of specimens are thus on one basis. Any point falling above the value q equals 1, indicates that the actual experimental stress concentration factor is greater than the theoretical factor. One point at room temperature and several at low temperature do have q values greater than one. This phenomenon has also been observed at room temperature by other investigators. No explanation is readily available for the occurrence of an actual factor greater than theoretical. In fact, there is considerable evidence pointing in the opposite direction. Neuber has developed along this line, a technical stress concentration factor based on materials characteristics and flank angle of the notch which reduces the theoretical factor as much as 50 percent or more and some agreement, especially in ferrous materials, has been found between this factor and the experimental factor obtained for

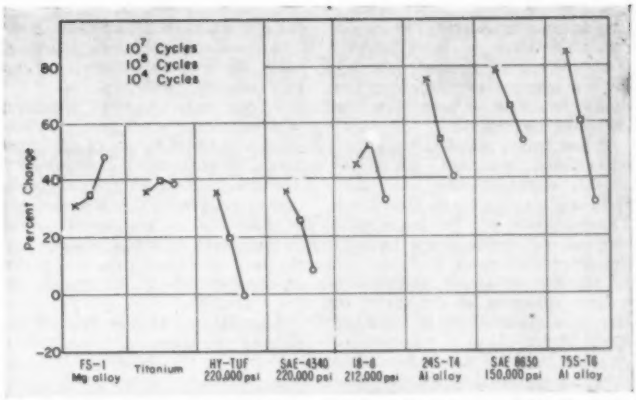


Fig. 4—Effect of exposure at —320 Fahrenheit on the fatigue strength of various aircraft construction materials at 10^4, 10^5, and 10^7 cycles using unnotched specimens.

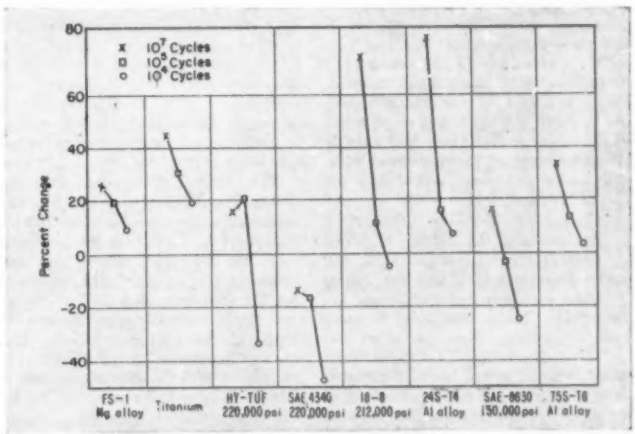


Fig. 5—Effect of exposure at —320 Fahrenheit on the fatigue strength of various aircraft construction materials at 10^4, 10^5, and 10^7 cycles using notched specimens.

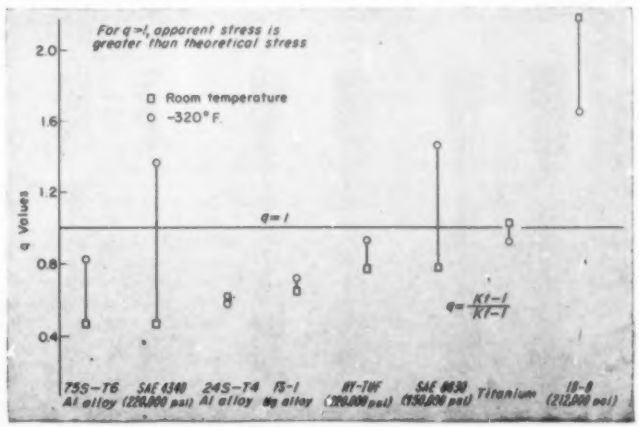


Fig. 6—Effect of temperatures on q values for fatigue strength at 10^7 cycles.

long lifetime fatigue tests. In view of the results shown in Fig. 6, however, it should not be assumed, especially for low temperatures, that stress concentration will be no larger than those calculated theoretically.

A few fatigue tests have been made on notched specimens of 24S-T4, 75S-T6 aluminum alloys and SAE-8630 steel (150,000 psi) at —420 F. The test results for the aluminum alloys fall within the scatter band for the temperature range 75 F to —320 F. However, there are indications of a knee appearing in the curves for both aluminum alloys at about 10^5 cycles whereas no such indications occurred at the other temperatures. Tests were not carried out past 10^6 cycles due to the large quantities of hydrogen consumed, but it appeared that the fatigue limit at — 420 F would be slightly higher than for the other temperatures, due to the leveling out of the curve past the knee.

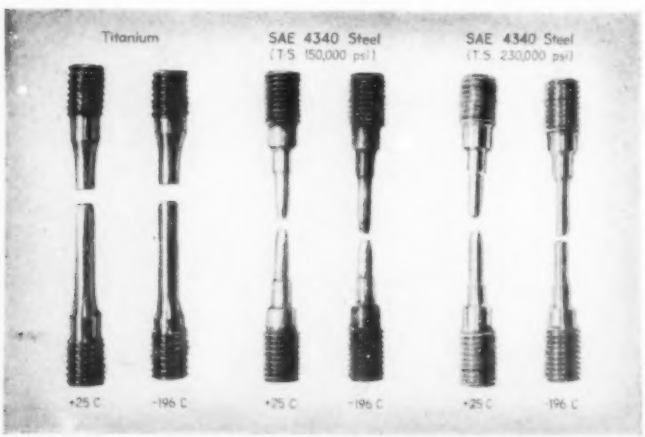
In the case of 8630, the curves at 75 F and —108 F were about parallel, with the —108 F curve a little higher. At —320 F, the curve was much lower than the other two for a low number of cycles, crossing them at about 200,000 cycles and then falling into the —108 F curve. The —420 F curve was still lower at a lower number of cycles, crossing the others at about 200,000 cycles and terminating at 10^6 cycles considerably above the others (58,000 psi compared to around 40,000 psi). The —420 deg. F curve was almost flat, however, from 10^4 to 10^6 cycles failing in 11,000 cycles at 65,000 psi stress. Failure occurred in 1,100 cycles at 85,000 psi compared to about 10,000 cycles at 125,000 psi at room temperature. This effect in the low cycle range again emphasizes the care which should be taken in design for applications at high stresses since only a few applications of load may cause fatigue failures.

Fatigue tests on small specimens with or without stress raisers such as notches are useful for indicating the effects of changes in environment. The actual values are not too significant to designers. The stress patterns in many machine components cannot be completely resolved and analyzed to the point where such basic data as that obtained in conventional fatigue tests are applicable.

The laboratory tests on standard and notched specimens at low temperatures indicate that the allowable design values determined at room temperature for the standard aircraft metals are safe for low temperature operations. No failures attributable to a change in mechanical properties of the material have been reported from operating stations in cold climates. However, this type failure might occur in other fields. Most low temperature failures in aircraft are caused by unequal contraction of unlike materials, producing galling or binding, with subsequent overstress and distortion or failure.

The effect of crystal structure, chemical composition, grain size and microstructure on the mechanical properties of metals at low temperatures has been investigated, and considerable data are published, especially for the iron base alloys. The low alloy steels normally contain two or more of the elements nickel, chromium, molybdenum, aluminum and vanadium in sufficient proportions to lower the transition temperature below that of steel with equal carbon content, but no other alloying element. With a large demand for low alloy steels, the supply of alloying elements becomes a problem in conservation and any savings which will not be detrimental to the end use of the product are desirable. The use of alloying elements to reduce the transition temperature should be approached by making a diagnosis of the effect of lower ductility on the serviceability of the part. Consideration of the notched impact test as the sole criterion of ductility is questionable unless service failures of components can be correlated with the impact values.

Impact tests are satisfactory for demonstrating a transition from tough to brittle fracture. The designer can eliminate the sharp notch since an impact load is seldom transmitted to the metal parts in flight or landing. The evaluation of the metal for low temperature serviceability requires more extensive data. The change in ductility in a tensile test is more informative and subject to better interpretation by an engineer. The best criterion is a simulated service test on the actual machine part or structure at the lowest temperature expected in service using the leanest alloy which satisfies the requirements for strength and hardenability at room temperature.



Unnotched tensile fractures at +25 F and —196 F show embrittling effect.

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Solenoid Air Valves In Automatic Machines

High speed and flexibility are the outstanding features of an electro-pneumatically operated device. The keypoint in any application is the solenoid valve, where the electrical and pneumatic circuits meet.

ROBERT C. MAY
The Clark Controller Company

IN GENERAL, solenoid valves used as a means of control for liquids and gases may be classified as two-, three-, or four-way operated. Which of these categories a particular valve falls into, depends upon the number of outlet ports available for doing work. The two way valve represents the simplest case. In action the valve either supplies air or cuts it off. There is no exhaust. If an exhaust is needed, provision must be made elsewhere in the circuit.

Three way valves have one exhaust port in addition to inlet and outlet

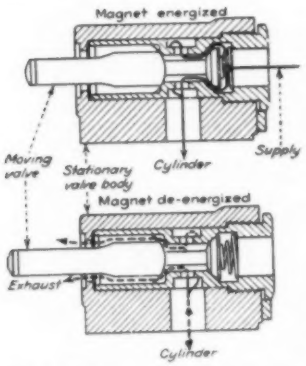


Fig. 1—Three-way valve of the poppet type. With the solenoid coil energized, the supply air is admitted to the cylinder for a work stroke. When the solenoid circuit is broken, the air supply is cut-off and the cylinder opened to exhaust.

apertures as shown in Fig. 1. In this valve, inlet and exhaust heads are on one shaft. Thus, opening one automatically closes the other. With the inlet port open, air may be admitted to the cylinder with which the valve is used. This cylinder is frequently of the single acting type, which has a power stroke in only one direction. The return stroke is accomplished by spring action. When the exhaust port opens, the trapped air is released and the cylinder returns to its original position. The valve illustrated is an

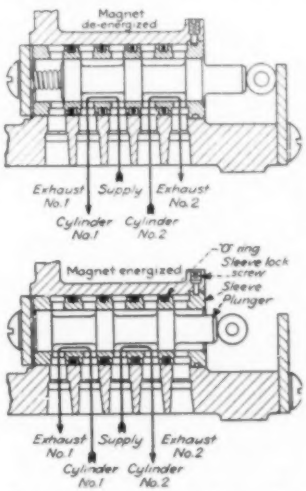


Fig. 2—Four-way valves are frequently of the slide type. Movement of the spool or plunger covers or uncovers the various valve ports in the proper sequence. Poppet type construction becomes cumbersome in four-way valves because of the number of ports that must be opened and closed.

example of poppet valve construction.

While the poppet design is used on some two- or three-way air valves, its use in a four-way valve often entails a complicated structure. Accordingly, four-way valves are usually of the slide type, in which valve action is accomplished by a sliding motion of the valve piston. The seal is produced by close fit of cylinder wall and piston. The air flow in a four-way

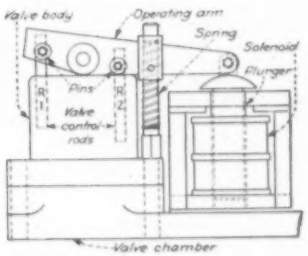


Fig. 3—Tandem mounting of valve body and solenoid is common form of construction. Rocker-like motion of the operating arm transmits solenoid action to the valve. An alternate method of actuating the valve employs a solenoid mounted in-line with the valve for direct action in shifting.

valve is depicted in Fig. 2 for both the energized and de-energized positions of the spool. In the diagrams, the ports are arranged for operation of two single acting cylinders. With the magnet de-energized, air is admitted to cylinder No. 1 and exhausted from cylinder No. 2. With the magnet energized, air is admitted to cylinder No. 2 and exhausted from cylinder No. 1. Four-way valves are designed to operate one double acting cylinder or two spring return cylinders.

Valve Operators

The conventional operator used on electrically actuated valves is a solenoid, which consists of a floating plunger moving in a stationary core. In one arrangement, Fig. 3, the valve consists of a heavy cast iron body, with a solenoid coil and plunger mounted at its side. The valve chamber contains the operating valves and inlet and exhaust passageways. The linkage mechanism consists of an operating arm connected to the solenoid plunger at one end, and to the valve control rods at the other. The valve control rods are coupled to the valve

sleeves, moving them relative to two sets of stationary apertures, which alternately connect the outlet pipes to supply and exhaust. Valve return is accomplished by means of a compression spring located centrally between the solenoids and the valve chamber. Action of the solenoid plunger and its compression spring alternately raises and lowers the sleeve assemblies on the two outlet valves, which supply air to their respective outlet pipes and cylinders.

Another common version of the solenoid valve employs an armature that is hinged at one end. The opposite end of the armature is pinned to the valve spool. The operating solenoid acts at approximately the midpoint of the armature.

The valves described above may be termed "direct" solenoid actuated valves. Another classification is the solenoid controlled, pilot operated valve, illustrated in Fig. 4. When the

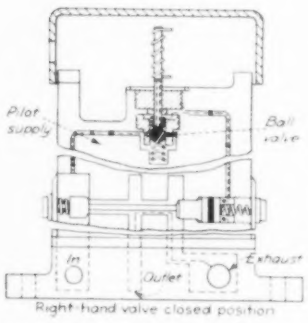


Fig. 4—Pilot operated valve. Control is electrical but the actual operation of the valve is done by pilot air pressure.

solenoid is energized, the solenoid plunger pushes down the rod beneath it, which in turn exerts pressure on a ball bearing working against the action of a spring. This permits a supply of air to pass through the pilot supply pipe past the ball bearing, which had previously blocked the aperture. Then, the air flows out through the pilot outlet and into both main valves. When the solenoid is de-energized, the pilot ball bearing is forced into place by spring action, sealing the aperture and preventing air from reaching the main valve. The air which has accumulated in the pilot line to the right of the valve is discharged through the center of the push rod above the ball bearing.

Applications

Control circuits for solenoid operated valves range from the simple to the very complex. In the most elementary case, the solenoid coil is directly connected to a single-pole make-break switch. This switch may be a pushbutton station, a limit switch or a cam operated device. For automatic control, valves connected in a simple circuit of this type may be operated by pressure, vacuum or temperature regulators, liquid level float switches, or devices of like nature which are provided with single pole contacts capable of handling the required power.

More frequently, relays are employed in the control circuit to boost the power available from a sensitive control device or instrument. With relays or systems of relays, very low current output can be made sufficiently large to actuate heavy solenoid actuated valves or even groups of such valves. In certain cases, an electronic amplifier must be included in addition to the relay. This requirement is true

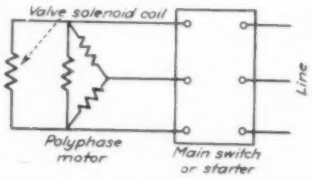


Fig. 5—Solenoid valve connected directly across motor terminals. Valve is open while the motor is running, but closes the instant the main switch breaks the power circuit. One application is in compressor systems where it is desired to trap air in tank after compressor has stopped.

when delicate transducers, whose output may be of the order of microamperes, is the sensitive element of the control circuit.

In Fig. 5 is shown a common circuit application for solenoid valves. The valve operating coil is connected directly across the motor terminals in such a manner that the valve opens or closes as required when the motor starts. Usually, normally closed valves are used so that when the motor starts, the valve opens and when it stops the valve closes. Such an arrangement is used for controlling circulating water in machines, such as air compressors and ammonia compressors. This arrangement is also practical for various types of gas and oil control on burners. A variation of this circuit is applicable to the operation of safety shut-off valves. In this case, the valve is provided with a manual operating device so that when the motor stops and the valve closes, the valve remains closed until opened manually.

Solenoid valves are the control medium in an air operated welding con-

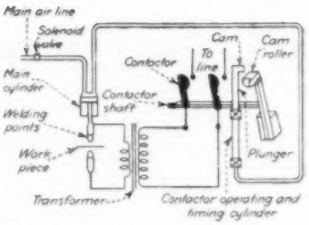


Fig. 6—Automatic spot welder uses air for operation and timing. When the solenoid valve is energized, the main cylinder closes the welding points. Contactor plunger does not move until welding points are closed, resulting in build-up of air pressure in the operating system.

tactor and timer. A schematic of such a machine is given in Fig. 6. When the welder operator squeezes the welding gun trigger, the electrodes come together and a heavy surge of current is momentarily sent through the electrodes performing the welding operation. The contactor works from back pressure from the main cylinder on the welder. This assures pressure between the welding points before the welding contactor closes and current flows. When the back pressure has built up to a predetermined value, the plunger moves upward at a definite rate of speed, and the hardened cam attached to the plunger closes the main contacts. After a predetermined time, depending upon the adjustment, the cam moves beyond the roller that it engaged and the main contacts open with a quick break motion.

The main air cylinder then exhausts, and as its pressure drops, the contactor air cylinder exhausts independently and the cam moves down quickly to its original position. The main contacts are not closed again on the down stroke, because the roller support is so designed that the cam overrides it on the way down.

Punch Press Clutches and Brakes

Air is widely employed to operate the control elements in punch presses. Choice of air is predicated on the fast action of air-operated mechanisms necessary for high speed operation of the press and safety of the personnel attending the machine.

A press usually has a heavy flywheel that is driven continuously by a main drive motor. When the crankshaft brake is released and the clutch is engaged, the flywheel rotates the crankshaft. This forces the press slide or ram down and then back up again. To stop the movement of the slide, the clutch is first disengaged and then the brake is applied. The clutch control must take care of starting the power movement of the slide when-

ever the operator desires and, most important of all, must unfailingly stop the press instantly whenever called upon to do so.

The arrangement of a typical press is seen schematically in Fig. 7. When the operation selector switch is in the "run" or "continuous" position, and the main disconnect is closed, the anti-repeat relay CR1 is energized through the normally closed contacts of the run push buttons. This relay is maintained in the energized position through the contacts of LS1 and LS4. The other contacts on CR1 set up a circuit to the coil of the clutch relay CR2, so that when the run buttons are pressed, CR2 will close. This energizes the magnetic air valve, engaging the clutch and starting the stroke of the press. As a safety feature, the operator must keep his hand on the run button until the dies of the press are almost closed. At that point, contacts LS2 and LS3 of the rotary limit switch close, establishing a holding circuit to the coil of relay CR2 and a circuit to the valve. During the upstroke of the press, contacts LS1 and LS4 of the rotary limit switch open for a short time. This drops out relay CR1 to prevent the possibility of accidents in case the operator has not released the run button. At the end of the stroke when the slide is again at the top, the contacts LS2 and LS3 open, de-energizing CR2, the valve relay.

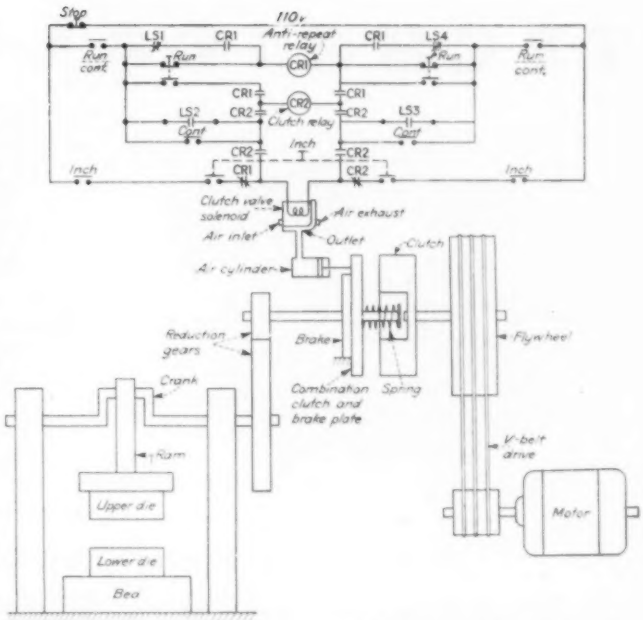


Fig. 7—Schematic of automatic punch press. Control is electrical, with air used to power the clutch and brake. Drive motor runs continuously, with intermittent ram motion being obtained by means of the clutch-brake operation. Descent of the ram is started by momentary operation of the run pushbutton. But if this pushbutton is held in, ram will not descend a second time. This is safety feature.

Glass Blowing Machine

One of the best applications to illustrate the complex control functions that can be accomplished pneumatically is an automatic machine for forming glass products. This machine duplicates the procedures followed by a craftsman in blowing glass. In his work, the craftsman uses a long blow pipe on which he sticks a small globule of molten glass. The globule is rotated against a flat plate to shape the glass. At the proper time, a few puffs of air are blown into the glass to make a void in it. Then, the blower swings the glass in the air to chill the outside and quickly transfers the glass bubble into a mold where the hot glass settles to the bottom. At this point, more air is blown through the pipe to cause the glass to set against the inside of the mold.

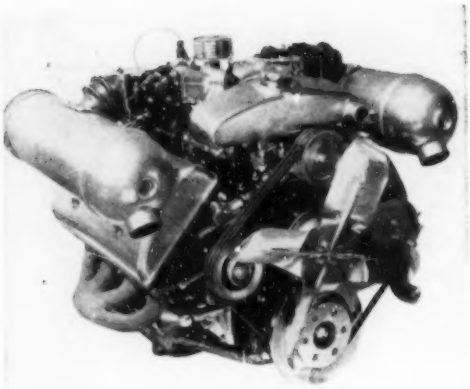
The machine automatically follows the routine of the glass blower. Electric timers and air valves pace the process. The machine has a swinging blow pipe, which is in a vertical position at the start of the process. The operator attaches a quantity of molten glass to the blow pipe. When one of the push buttons is pressed, the pipe swings back and forth against a large curved forming guide in front of the machine. At the same time, puffs of air controlled by solenoid valves emanate from the end of the pipe. These puffs of air transform the glass into a bubble. The pipe then returns to its vertical position and a hinged air-operated mold closes around the glass. Air is again blown into the machine. The glass is automatically held for the right period of time against the mold. After this time, the mold is opened pneumatically and the glass article is removed in finished state.

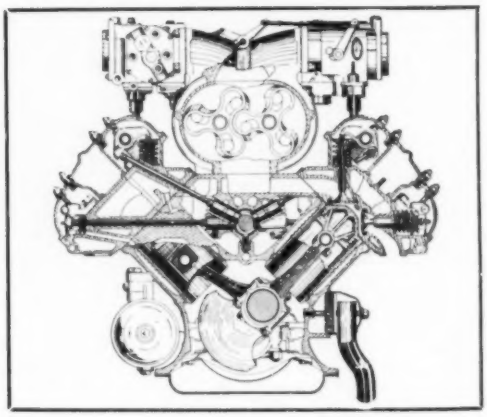
Automation

Among the latest design innovations in production machines is the development of automatic handling equipment. Parts are transferred from one station to another without manual handling.

One such installation in an automobile manufacturing plant is set up for the processing of one half of a rear axle housing. After being removed from the incoming conveyor automatically, it is put through five different press operations to form and trim the banjo. Then, the finished part is placed on the outgoing conveyor. This is accomplished by placing five presses in a circle along with a load, unload and gage station. In the center of this circle, an automatic turret is located. This turret has eight arms which extend and retract, and the complete turret is capable of indexing. The housing is received on the incoming conveyor, removed from the conveyor automatically and placed in the load station. The arms on the turret extend, grip the axle housing, retract and then index. At the end of the index stroke the turret is locked and the arms extend, placing the housing in the gage station. This checks the position of the housing in the arm to make sure that it is lined up properly and will enter each press without difficulty. The turret arms are then retracted, indexed and extended, placing the housing in the No. 1, No. 2 and No. 3 forming presses; and the No. 1 and No. 2 trim presses. Next the housing is placed in the unload station which automatically removes the housing from the turret arms and loads the completed housing on the first empty hook of the outgoing conveyor. Much of the work involved in moving the piece from press to press is actuated by air, working through air cylinders attached to clamps, fingers or other such mechanical devices.

TECHNICAL NEWS





Aluminum Engine Powers Experimental Buicks

BUICK'S TWO CARS OF THE FUTURE, the sleek La Sabre designed by Harley J. Earl, General Motors vice president in charge of styling, and the aluminum-bodied convertible styled by Charles A. Chayne, General Motors vice president in charge of the engineering staff, will both be powered by the XP-300 engine which Chayne has designed.

The XP-300 is strictly an experimental engine, built without consideration to production requirements. It weighs only 550 pounds, nearly 250 pounds less than the engine in a Buick Roadmaster, yet its power output is more than double. Rated at 300 hp, the engine has developed as much as 335 hp in dynamometer tests.

It has a bore and stroke of 3.25 in., with a displacement of 215.7 cu in. compared to 320.2 cu in. for the Roadmaster engine. It has a compression ratio of 10-to 1 and is supercharged to 18.2 psi manifold pressure at 5,000 rpm.

Since both cars are extremely low, the overall height of the engine had to be kept to a minimum. Chayne over came this problem by using a very shallow oil pan, a relatively small flywheel and by dividing the crankcase into two sections. The lower section carries the main bearings, water jackets and cylinder sleeves; the upper section contains the camshaft, valve lifters and intake manifold.

The crankcase is of cast aluminum alloy instead of cast iron. Use of aluminum resulted in considerable weight-saving. Cylinder sleeves are of the "wet" type cast from "Ni-Resist" iron, which has a higher co-efficient of expansion than the more commonly used alloys, and therefore more closely approaches the expansion rate of the aluminum cylinder head and pistons. The upper halves of the main bearings are fitted with steel inserts. The lower halves are forged steel.

To compensate for the low inertia of the small diameter flywheel, Chayne substituted a bronze wheel for a steel one. The high tensile strength of bronze, together with its high specific gravity, makes this metal preferable for a flywheel in an engine operating at high speeds, and reduced the overall height of the engine by 1.5 inches.

By nestling the upper section of the crankcase deep between the two banks of cylinders, enough clearance was obtained to install a "Roots" type blower between the cylinder heads without increasing the engine height. This location of the blower resulted in an intake manifold that is very short and contains a minimum of bends.

The aluminum cylinder heads have fully-machined combustion chambers with intake and exhaust valves set opposite each other at 90 deg, and with the spark plug at the top center of the chamber.

The engine was designed for high output at speeds considerably below those ordinarily attained in highly supercharged racing engines, and the valve sizes, ports and cams were carefully developed with this objective in mind. The position of the valves at 90 deg to each other, together with the cylinder banks at 45 deg to the horizontal, resulted in the intake valves being vertical. This made the ports a minimum length and contributed materially to the "free-flowing" characteristics of the intake manifold. Exhaust valves are sodium-cooled and the guides for both the intake and exhaust were shrunk into the aluminum cylinder head. Because of the very high combustion chamber pressures, specially designed laminated steel head gaskets are used.

Piston heads are domed to give the desired combustion chamber shape. The dome also adds materially to the structural strength of the pistons.

A single camshaft, chain-driven from the front, is located between the two banks of cylinders. Valve lifters are all hydraulic, and self-adjusting. Since the exhaust valves are horizontal, their push rods operate through drilled bosses in the cylinder block between the cylinders, and the rocker arms are carried on short, individually mounted shafts. The valve mechanism is designed to operate without clatter or bounce at speeds up to 6,500 crankshaft rpm. Valve rockers arm covers and the spark plug covers are aluminum alloy castings.

The supercharger is driven by three belts from a pulley located on the front of the crankshaft. Two aircraft type pressure carburetors are used in place of the conventional float type. One supplies gasoline to the engine, the other methanol. The gasoline carburetor is used for all normal driving and gives satisfactory operation with present-day premium gasoline for en-

gine operation below 125 hp. Methanol is required only for high outputs; consequently, the methanol carburetor comes into action only after the gasoline carburetor throttle reaches a nearly wide-open position. Two separate fuel tanks and electric fuel pumps supply the carburetors. Stainless steel exhaust manifolds that are used are of the collector type.

The oil pan extends from the front of the engine to the rear of the housing, enclosing the flywheel. Since the flywheel extends below the oil level, a small dry sump is provided around the lower part of the wheel to prevent unnecessary churning of the oil.

Hardness Tester For Hot Electrodeposits

A MICROHARDNESS TESTER for measuring the hardness of electrodeposits at elevated temperatures has been developed by the National Bureau of Standards. The new apparatus is based on the diamond-indentation method now used to measure the high-temperature hardness of bulk metals. However, because of the relative thinness of electroplated coatings and their softness at high temperatures, the device has been especially designed to make indentations of microscopic depth under very low loads. Other advantages over previous instruments should also make the tester of value for determining the hot-hardness of bulk metals; in particular, it is expected to find important application in studies of the properties of new types of high-temperature alloys.

Although a number of different devices using indenters of various types have been developed for measuring the hot-hardness of bulk metals, none of these instruments has been found suitable for electrodeposits. In general, the indentation methods produce surface impressions, usually in the form of a four-sided pyramid, whose measurable dimensions vary with depth of marking and thus indicate degree of hardness. The instruments used with bulk metals either employ indenters unsuitable for thin metal coatings or else use heavy loads to produce deep indentations which would pierce the coatings. For testing electrodeposits, other instruments known as microhardness testers have been developed to produce very shallow indentations under low load, but until now such devices have not been applicable to high-temperature work. NBS therefore undertook to develop a practical method of testing the hot-hardness of electrodeposits. The resulting apparatus overcomes the disadvantages of previous instruments and provides data on electrodeposits at temperatures up to 900 C.

The new apparatus consists essentially of a Vickers diamond indenter mounted on the shaft of fused silica; a mechanical device for raising and lowering the indenter; an electric furnace for heating the specimen; and a micrometer device for orienting the specimen under the indenter. Loading mechanism indenter, and furnace are all enclosed in one compact, self-contained unit. An inert atmosphere slightly above atmospheric pressure is used in the tester.

The indenter assembly weighs about 200 g. Additional load can be applied to the indenter by placing weights on top of the assembly. Lower loads for use at elevated temperatures are obtained by increasing the gas pressure in the tester.

Unique Vibration Rig For Testing Stop Nuts

A UNIQUE HIGH-TEMPERATURE VIBRATION TESTING RIG has been set up at the Union, N. J. plant of Elastic Stop Nut Corp. of America for testing critical vibration requirements of stop nuts, especially those used in aircraft manufacture.

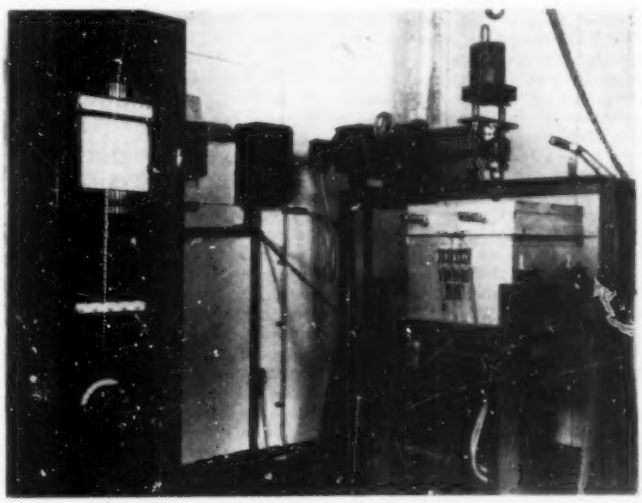
These various types of stop nuts must be designed to operate at sub-arctic temperatures—whether because of the altitude of the aircraft, or the geographical weather conditions. The testing rig is therefore so constructed that it can provide ambient temperatures ranging from sub-arctic to 2,000 degrees. The top range is significant in view of the extremely high temperatures at which turbo-jets operate.

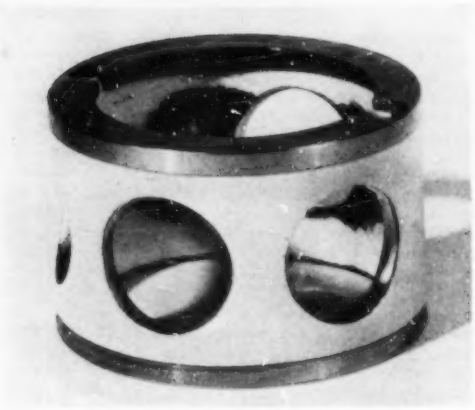
The rig's flexibility is such that it can simulate conditions more severe than the normal vibration encountered in piston and jet engine operations. It consists of a cam-operated hammer mechanism that produces the required vibrations by both electrical and mechanical means. The drive is furnished by a variable drive motor and speed ranger that is capable of speeds from 590 rpm to 4,700 rpm. It is usually run at 2,760 rpm.

The testing arbors, in which the nuts are placed for vibration tests, are swung into position under the hammer, with the free end of the arbor positioned in an oven placed below the hammer mechanism. The load on the hammer and arbor weighs 65 pounds, sufficient to keep the arbor steady. The arbors are made of high-temperature alloys, and specific arbors are selected for use with different temperature ranges. A series of thermocouples are located in the oven to assure uniform oven temperatures, and each of the thermocouples is indicated on the chart on a master control panel.

Furnished with an indicating controller with input proportioner, the control panel provides accurate control within a temperature range from 200 deg F to 2,000 deg F, and permits vibration of stop nuts at any desired temperature within these limits.

As the unit is set in operation, an air jet is directed over and above the cooling fins on the arbors to dissipate heat before it reaches the driving mechanism. Periodic checks are made while tests are under way, and operators can remove the arbors to examine the nuts for structural failures.





Ground and Lapped Porcelain Enamel Solves Valve Problem

THE STAINLESS STEEL BODY of an aircraft fuel selector valve made by the Aero Supply Mfg. Co., Inc. is now being coated on selected areas with a porcelain enamel that can be ground and lapped.

Service conditions of the valve require a temperature and wear resistant, non-galling and corrosion-free surface that can be run totally dry for several thousand cycles. Most metal choices that can withstand the attacks of sea water, abrasives and chemical additives present in the fuel, fail under the extended dry operation. Service records indicate that all-metal valves need repair about every three months, while a prototype of the porcelain enamel design has been used for more than five years without maintenance.

The plug casting for the new valve is first cast in stainless steel and machined to precise dimensions. The outer diameter of the plug, which is the wearing surface in contact with the valve seals, is then porcelain enameled with a special, acid-resistent formula. As shown in the illustration, the extreme top and bottom of the plug must be free from the porcelain. The balance of the exterior diameter is recessed to receive the coating, the thickness of which is maintained within 0.015-0.020 inches. Strict control of the porcelain enamel formula and firing temperature is required to assure a fully matured coating at a furnace firing temperature that will not warp the casting.

A final grinding and lapping operation on the external dia of the plug brings the final finished tolerances of the plug to within plus 0.001 and minus 0.000 inches.

Automatic Injection Aids Car Engines

MORE POWER FOR the automobile engine for high speeds and hill-climbing is provided with an improved alcohol-water injection device which automatically supplies the mixture at a rate which increases in proportion to the engine speed.

Although it is well known that a mixture of water and alcohol will result in better performance of an internal-combustion engine, at ordinary legal speeds on level roads, regular gasoline gives satisfactory power. This invention, for which Gilbert and Barker Mfg. Co., West Springfield, Mass., has acquired the patent rights, is to provide the injection when higher speeds are desirable or added power is need for hill-climbing without engine knock.

The injector is a pump controlled by a switch which is actuated by the suction of the engine manifold. This results in injection during the periods when the engine is working hard. The circuit breaker of the ignition system of the engine is used as a vibrator to convert the current from the storage battery to the high frequency pulsating current needed to operate the pump.

Foreign Metallurgists Guests of U.S. Taxpayers

CLEVELAND, OHIO — The Economic Cooperation Administration has set aside more than $500,000 to enable eleven groups of top metallurgists from Marshall Plan countries to attend the World Metallurgical Congress in Detroit, Oct. 14-19, the American Society of Metals announced recently.

Some 500 metal experts from 21 ECA and non-ECA nations are expected to participate in the meeting. Of these, more than 250 are under direct sponsorship of ECA and will receive travel and subsistence allowances within the continental United States as part of the Administration's Technical Assistance Program.

Traveling teams comprising 300 Marshall Plan visitors will inspect the state of American metal industry in a series of top level tours preceding and following the dates of the Congress. Four weeks prior to the Congress, eight teams, or "Study Tours" as they are called, totaling almost 200 metallurgists will journey to 150 plants in 13 states and 57 cities. About 50 of these visitors will be traveling at their own private, company or government expense. All arrangements for these eight tours were made by the Society.

Three other tours will start after the Detroit meeting is over. They will visit top American concerns specializing in (1) nonferrous heavy metal fabrication, (2) galvanizing techniques and (3) non-ferrous smelting and refining operations. These post-Congress tour arrangements are handled under ECA by Comdr. W. H. E. Fitzgerald (USNR), Vice President of the Metal-

lurgical Research and Development Company, an international consulting organization with headquarters in Washington, D. C.

The Congress in Detroit is the first such meeting ever staged and is sponsored solely by the metal society. It will run concurrently with the 33rd National Metals Exposition and Congress. The latter is the largest annual industrial exhibit in the world and is estimated to attract 45,000 persons, all of them professionally interested in the metal working fields.

Auxiliary Power Unit For Guided Missiles

A MILK-BOTTLE SIZE auxiliary power package for guided missiles with a 6 in. dia, 60,000 rpm axial flow turbine has been developed by AiResearch Corp. As a second power source within a missile, the unit will operate such elements as stabilizers, air surface and guidance controls during supersonic flight.

The power package weighs but 16 lb and consists of a partial admission axial flow turbine, a reduction gear box, a 12,000 rpm induction generator and a gear-type hydraulic pump. Current performance figures are 2.75 gpm of oil at 1,500 psi and 750 w of 400 cycle, 115/208 v, 3-phase alternating current. By minor changes in the turbine nozzle and gas generator, the hydraulic pressure may be doubled and the electrical output increased to 1,300 watts.

In operation, hot gases ignited in a gas generator power the turbine wheel. The alternator and the hydraulic pump convert the turbine shaft power into electrical energy and hydraulic power.

Since neither brushes nor slip rings are used, the unit is particularly well suited, for missile application where large changes of altitude are encountered and where radio noise is critical. It has been designed for severe vibration and shock loads.

Industrial Applications For Ultrasonic Energy

ULTRASONIC ENERGY as an abstract phenomenon, like electrical energy, has little or no practical significance. However, when used in conjunction with specially designed equipment, a wide variety of industrial applications can be realized. Such an application, completed by the Brush Development Company of Cleveland, involves the treating of paper mill wastes with high frequency sound waves to remove fibre particles that are too small to be picked up by screening. The ultrasonic beams group the fibres and arrange them in soldier-like rows which are easily combed out.

The Brush installation utilizes a piezoelectric ceramic in its transducer (see PE Feb. 1950, p 147) to obtain vibration frequencies as high as four million cycles per second. Degassed oil under pressure is used to transmit energy from the ceramic element to the process material. This company is also involved in applying ultrasonic energy to laundering, cleaning of fabrics and metals and the production of petroleum products, paints, chemicals and pharmaceuticals.

Another industrial installation of ultrasonics was designed by the General Electric Company for cleaning the tiny openings in electric shaver heads. This machine uses an RF generator to supply high frequency voltage to a quartz crystal which generates the sound waves in a saline solution. These waves then pass through a thin diaphragm into the cleaning solvent through which the shaver heads are conveyed. The result is the most thorough cleaning job yet obtained by any process.

A third industrial application comes from Mullard Limited of London, England. It is an ultrasonic bath for the rapid soldering of small, complex parts made from aluminum or aluminum alloy. The molten solder is agitated ultrasonically by means of a transducer, composed of a stack of iron alloy laminations, to break up the highly refractory oxide films which normally form on aluminum. Thus, no flux is required and soft solders can be employed.

An investigation of the possibilities for obtaining improved, simpler and more fool-proof spotwelds in light metals by the use of ultrasonics is being conducted by the Naval Bureau of Aeronautics, in cooperation with Aeroprojects Inc., West Chester, Pennsylvania. This procedure involves the application of high intensity elastic vibrations through the welding electrodes during the welding operation.

Results to date on thin aluminum sheet have indicated that significant effects on the metallurgical and mechanical properties of the spotwelds are possible using this technique. The following conclusions have been drawn thus far:

(a) Ultrasonic vibrations of the order of 15 to 20 kilocycles have been effective in refining the cast grain structure of spotwelds in thin clad aluminum sheet. In some instances it has been noted that weld nugget size was more uniform than that of typical samples spot welded by the conventional method.

(b) Improvements were noted in the average and minimum shear strengths, in the coefficient of variation, and in the incidence of weld cracking.

(c) There is some indication that improved fatigue strength in spotwelds may be possible with ultrasonic spotwelding.

(d) Substantial reductions were noted in the surface electrical resistance of both cleaned "as received" alclad aluminum sheet.

MALTON, ONTARIO—First all-Canadian jet fighter has been built by A. V. Roe Canada, Ltd. Its notable feature is the two Orenda turbojet engines which have already undergone many types of bench tests and late in 1950, was used to power an American Sabre F-86. During the present year an Orenda-powered Sabre fighter flew from Toronto to Montreal at an average speed of 665 miles per hour. The engine is claimed to be more powerful than the jet used in the Sabre when it established a world's speed record of 670 miles per hour.

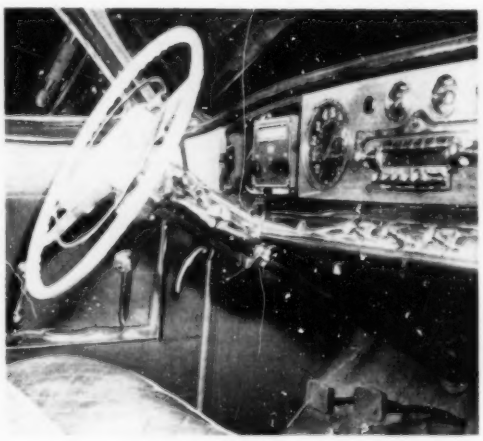
•

A NEW COLD ROLL MILL recently installed at the Naval Ordnance Lab., White Oaks, Md., will soon commence producing super-fine steel tape for use in pulse transformers, magnetic amplifiers, guided missiles and other HF applications. The Sendzimir mill will take steel strips 0.025 in. thick, roll them through oil-filled chamber where thickness is reduced to 0.0005 in.; strips can be produced in widths up to 8.5 inches. The machine weighs 6,000 lb, is powered by five electric motors.

•

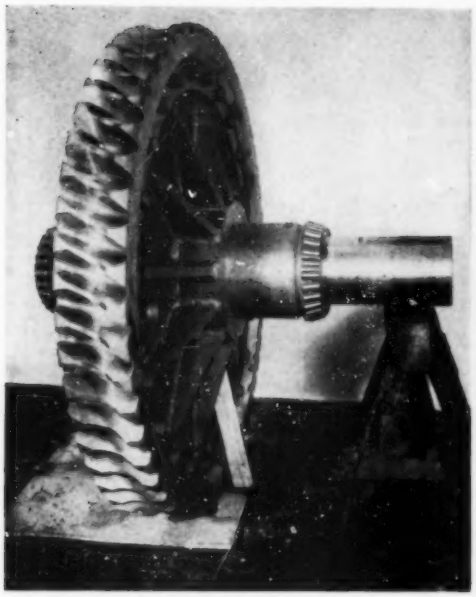
LEAKAGE OF CURRENT in armatures of generators and motors in diesel-operated locomotives is effectively reduced through vacuum impregnation of these units with thermosetting resins. Vacuum impregnation is achieved by exhausting air from a chamber in which the armatures are placed. When a high vacuum has been reached, the chamber is flooded with liquid resinous insulating material. Due to the complete absence of air and moisture, the resin thoroughly penetrates all armature windings and assures permanent, efficient insulation supplementing the conventional covering.

UNPRECEDENTED SUPERSONIC SPEEDS and altitudes were attained by the Douglas Skyrocket using rocket power after being carried aloft and air-launched at 35,000 ft from a B-29. The sweptwinged Skyrocket is normally powered by both jet and rocket engines but in these flights the jet engine was eliminated to accommodate an additional amount of rocket fuel. One ton of propellant per minute is thrust through the craft's rocket tubes. When electrically released by the motor ship, the pilot starts the rocket engines and begins a high-speed climb. At proper altitude he levels off and accelerates to maximum speeds consistent with altitude as well as fuel limitations. When propellants are exhausted, he executes a spiral descent and lands deadstick. The belly of the B-29 had to be altered and strengthened to carry; and conform to the contour of the Skyrocket.



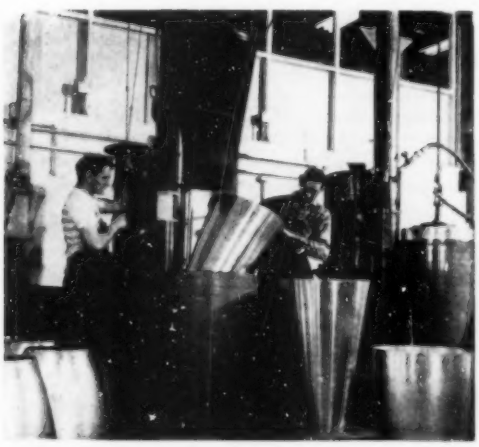
CIVILIAN VERSION OF the miniature radio equipment being adopted by the armed forces is the compact, low-cost short wave receiver, seen in the auto's glove compartment, above. Designed especially for civilian defense networks, the 9-tube unit weighs less than three pounds. The receiver is of shockproof design, suitable for mobile applications such as ambulances and police vehicles. The Sonar Radio Corp. of Brooklyn, N. Y., is the manufacturer of these miniature receivers.

OILFIELD TRUCK ordered by Shell from Scammell Lorries Ltd, England for use in Borneo tilts some 50 deg while a 14-ton load is winched aboard. As load was pulled onto the vehicle, the front gradually returned to the ground. Four-wheel drive, high chassis and engine, plus pivoted, transverse front spring permits travel over rough, sandy or boggy ground. Fitted with a heavy 50,000 pound line-pull winch, the vehicle also has "gin poles" which can be erected in the form of a crane.



NICKEL BRONZE WORM GEAR WHEEL is part of the largest standard enclosed worm gear speed reducer ever built by DeLaval Steam Turbine Co.; a 30 in. center balance unit that transmits 200 hp at 410 rpm with a 17 2/3 to 1 ratio. Worm is made of nickel-chromium-molybdenum steel quenched and tempered to provide necessary combination of mechanical properties.

TURBINE WHEELS are cooled with water spray after being fitted with thirty foot shaft. Wheels were heated before assembly to get shrink-fit after cooling. Unit shown is a 60,000 kw low-pressure element of a 120,000 kw cross-compound General Electric industrial steam turbine. Inspector then checks fitting of keys and position of wheel on the shaft.



EXPANDING RUBBER DIE is used by Vic Pastushin Ind., Inc. of Los Angeles to form aft section of 230 gal jettisonable fuel tank for aircraft. Sections are formed in less than 3 min from a rolled and Heliarc steam-welded aluminum bank at a cost saving of 75 percent. Previous process, spinning, required 15-20 minutes. This new process also stretch forms steel or aluminum cones into forms with spherical contours for aircraft cowlings, propeller spinners, missile casings and practice bombs.

DOUBLE REAR DOORS on armored carrier made by Food Machinery and Chemical Corp. permits 12 soldiers to quickly enter and leave. Powered by Army's newest 6-cylinder, air-cooled engine and cross-drive transmission, the 20 ton carrier traverses same terrain as light and medium tanks, can go over 35 mph on improved roads, turn in its own length and climb 60 percent slopes. It will protect infantrymen from small arms fire and shrapnel while enroute to front lines with tank spearhead.

SILASTIC* can be used to fry an egg or keep aircraft flying under icing conditions

Consider resistance heating elements embedded in Silastic. Among many present and potential applications are: the anti-icing of air intake doors on jet engines; deicing strips for aircraft wings, helicopter blades, and camera mechanisms; electric blankets and soil heaters. Such applications are practical because extreme temperature Silastic stocks are the only rubber-like materials that stay elastic at temperatures ranging from −100 to +500°F.

Certain Silastic stocks are also excellent electrical insulating materials. Dielectric strength and dielectric constant are practically unchanged by 4 months of accelerated aging at 175°C. (347°F.). High heat conductivity enables Silastic insulated coils to operate under the same load at temperatures as much as 50% below the temperatures of identical coils impregnated with electrical insulating varnishes.

And remember, Silastic also repels water and ice; shows excellent resistance to oxidation, outdoor weathering, ozone and to a variety of hot oils and chemicals. That's why Silastic is so challenging as a heating pad; so indispensible as a gasketing, sealing and electrical insulating material.

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Torsion Spring Charts For Round or Square Wire

H. F. ROSS
Research Division
United Shoe Machinery Corporation

THESE CHARTS are for the rapid calculation of helical types of torsional springs which are loaded in a direction tending to reduce the diameter of the coil. These data hold for average conditions where either static or relatively slow varying loads are applied. In applications, where rapid action occurs, the allowable bending stress values plotted in Fig. 3 should be reduced depending upon the particular range of stress until the endurance limit is approached.

These springs differ from compression springs since torque loads cause bending stresses in each coil. With the inner surface in compression, the critical tensile stress is at the outside. However, the coiling of pretempered wire results in a residual compressive stress in the outer layers which reduce the tensile stress particularly for springs with lower D/d ratios. Thus, the actual stresses in the cross-section approach a uniform stress condition rather than the uniformly varying distribution from the center as calculated by the formula. The result is a greater load capacity. In other words, the apparent or calculated tensile stresses to which such springs may be subjected without permanent set can be considerably higher than the tensile elastic limit. Such formula calculations do not determine or represent the actual stresses but are quite useful on a comparative basis.

It is common practice to include an average anticipated friction loss of 10 percent in the theoretical torque. Actually the efficiency varies considerably with: the type of ends, whether free or clamped; the length of spring; and the relative proportions as they affect buckling on the supporting shaft. The chart in Fig. 4 will closely agree with springs which are mounted friction-free.

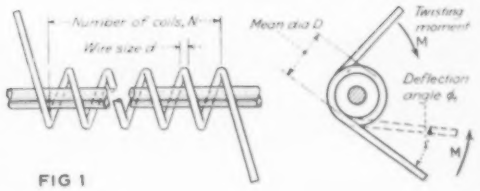


FIG 1

EXAMPLE—Referring to Fig. 1, a round music wire spring has the following specifications:

$D = 1.0$ in.; $\phi_1 = 250$ deg.; $M = 15.0$ lb in.

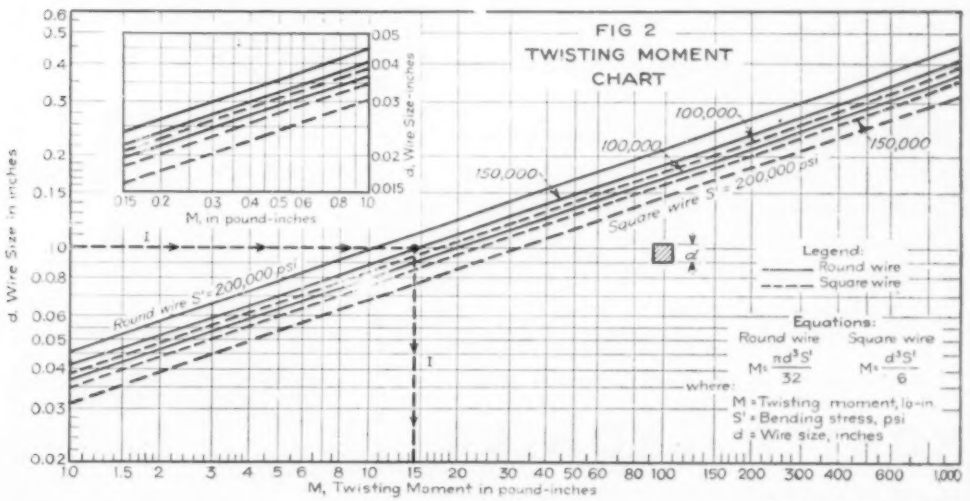
Find: d, S, N

Assume a stress, say 150,000 psi, and from Fig. 2: choose a standard wire size d of 0.100 in. This corresponds to 14.7 lb in. at 150,000 psi (see Line I). For 15 lb in. torque, stress would be (15/14.7) × 150,000 or 153,000 psi.

Referring to Fig. 3, this stress is satisfactory since it does not exceed the recommended tensile stress S of 159,000 psi (Line II). From Fig. 4, the unit deflection ϕ_1 is 18 deg per coil at 150,000 psi. Since the total deflection is 250 deg, the number of coils required is:

$$N = \frac{250 \times 150}{18 \times 153} \text{ or } 13.6 \text{ coils}$$

On the basis of the maximum recommended stress, the moment can be increased to: $M = 14.7 \times (159/150)$ or 15.6 lb in. and the deflection, ϕ_1 to $18 \times (159/150)$ or 19.1 deg per coil. Using the relation in Fig 3, the maximum tensile stress limit S_m permits the maximum moment M_m to be 15.6×1.33 or 20.8 lb in. and the corresponding deflection, $\phi_m = 19.1 \times 1.33$ or 25.5 deg per coil.



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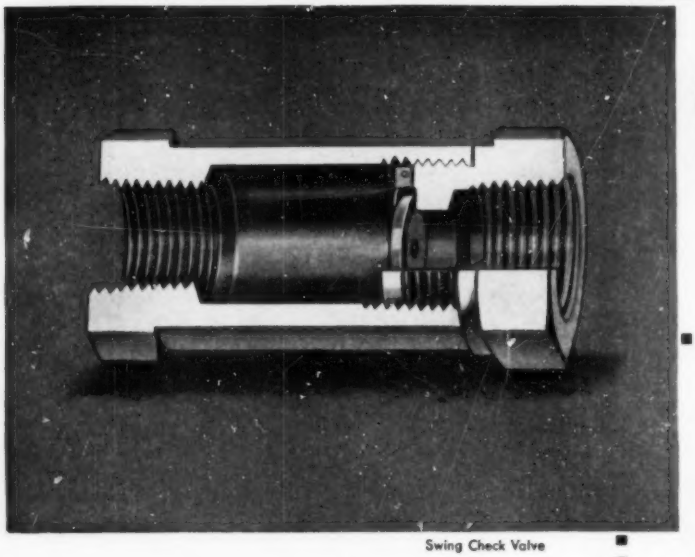
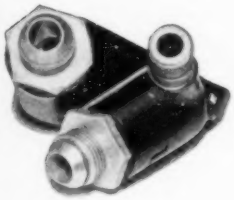
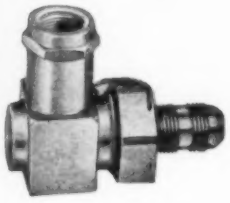


Swing Check Valve



Double Swing Check Valve



Double Swing Check Valve

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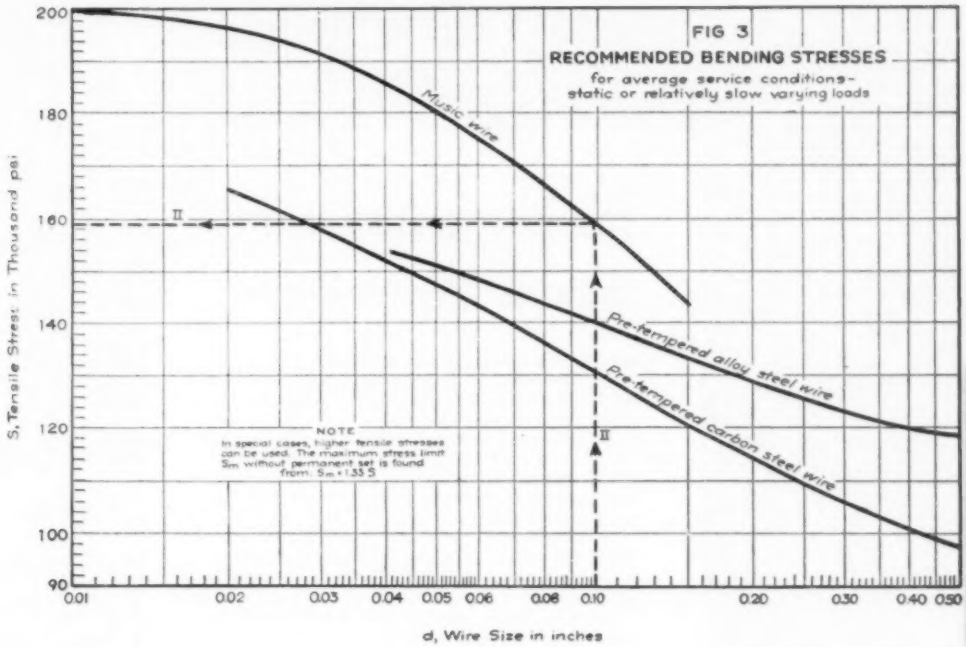
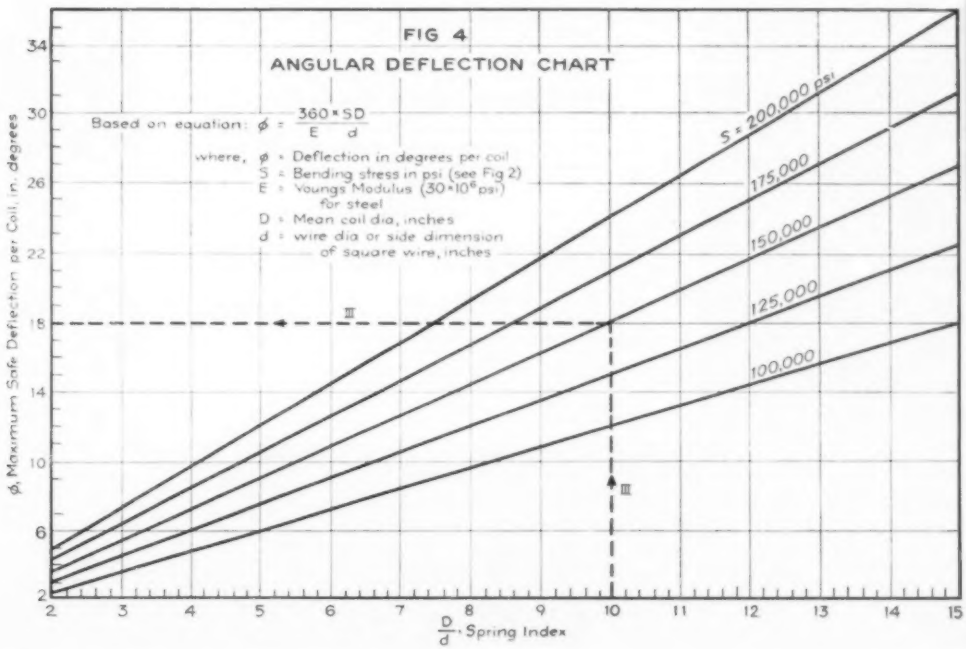
Torsion Spring Charts (continued)





The metal coating that stretches like r-u-b-b-e-r

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Compare this with conventional galvanized sheets. When these sheets are drawn or formed severely the coating invariably flakes or peels. This exposes the base metal to early rusting and failure.

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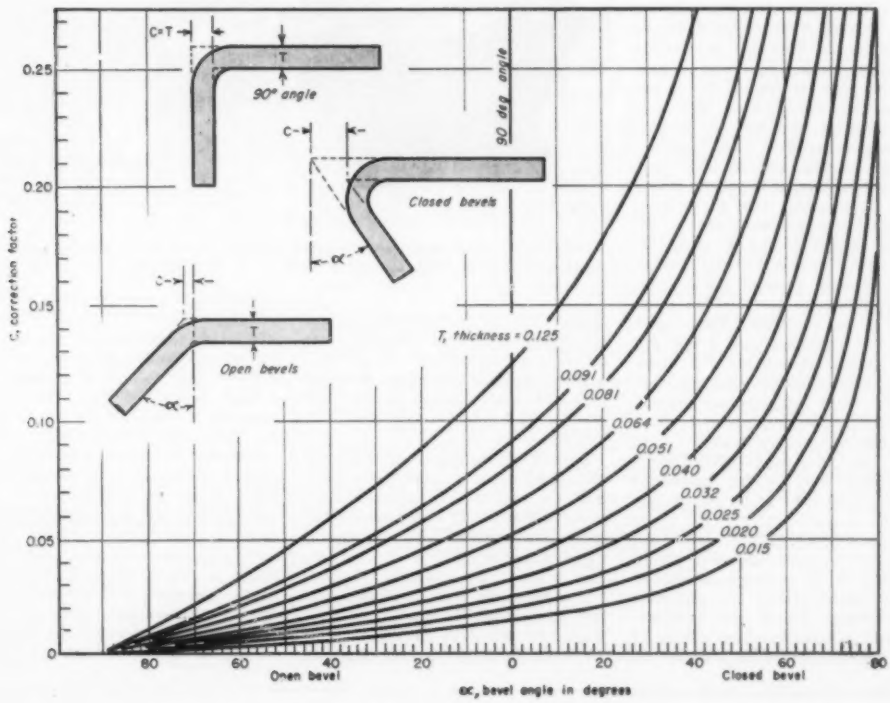
ARMCO

Sheet Metal Bend Allowance and Correction Charts

Recommended Minimum Bend Radius R For Sheet Metal

Material Thickness	Aluminum Alloys			Magnesium		Steel		
	24ST and Alclad	24SO and Alclad	2S, 3S, 52S ½ Hard	Cold Bend	Hot Formed	Stainless Annealed	Stainless *½ Hard	Low Carbon, X-4130 Annealed,**
Up to 0.015	0.06	0.06	0.03	0.06	0.06	0.03	0.03	....
0.016	0.06	0.06	0.03	0.09	0.06	....	....	0.03
0.020	0.09	0.09	0.03	0.12	0.06	0.03	0.06	0.03
0.025	0.12	0.09	0.03	0.19	0.06	0.03	0.06	0.03
0.032	0.12	0.09	0.06	0.25	0.09	0.03	0.06	0.03
0.040	0.12	0.09	0.09	0.31	0.99	0.06	0.09	0.06
0.051	0.19	0.09	0.09	0.38	0.12	0.06	0.09	0.06
0.064	0.19	0.09	0.12	0.50	0.19	0.06	0.12	0.06
0.072	0.25	0.12	0.16	0.56	0.19	0.09	0.12	0.06
0.081	0.31	0.12	0.19	0.62	0.19	0.09	....	0.09
0.091	0.38	0.16	0.19	0.69	0.25	0.12	....	0.09
0.102	0.44	0.19	0.19	0.75	0.25	0.16	....	0.12
0.125	0.50	0.19	0.19	1.00	0.31	0.19	....	0.12
0.156	0.69	0.28	0.28	1.25	0.44	0.19	....	0.19
0.187	0.81	0.38	0.38	1.50	0.50	0.25	....	0.19
0.250	1.00	0.50	0.50	2.00	0.62	....	....	0.25
0.375	....	....	....	3.00	1.00	....	....	....

Note: *For bends up to 90 deg.
**This applies to 8630 and similar steels.



NEW COMPONENTS-

Interchangeable Heads on Metering Pumps

Metering small volumes of solutions in a laboratory or dispensing controlled volumes of liquids in processing operations, suggest a variety of functional applications in the industrial field for these small stainless steel pumps.

Adaptable to the control of solutions, where the prevention of contamination is important, these pumps are also effective in dispensing hot or cold, viscous or non-viscous liquids, grease, wax, chemicals and compounds, and may be used on automatic drink dispensing machines.

The pump heads are instantly demountable and interchangeable on fixed speed or variable speed driving units, allowing for spare units for various liquids. Having a positive displacement action, delivering a non-pulsating flow of liquid, the pumps will maintain sterility while dispensing critical liquids, and will not react to the corrosive action of most liquids.

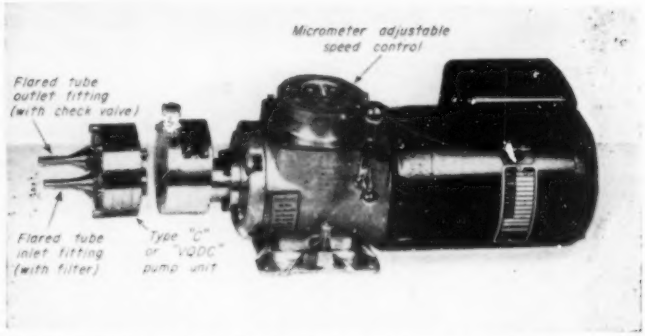
These pumps are available with two types of variable speed driving units, and various size fixed speed motorized transmissions.

Type VQDC-5520-EM, quick demountable, variable capacity pumps, equipped with variable speed transmissions, have a water output range from "0" to 25 cc/sec. These units, which are equipped with $\frac{1}{8}$ hp, 115 v, 60 cycles, a-c motors, and micrometer speed regulators which are adjustable while running, are recommended for laboratory use or continuous production operations. Type VBC-5520-EM, a rigid mounted pump is also available. Overall dimensions of both are $6\frac{1}{2}$ x 8 x 18 in. Net weight is 33 lb.

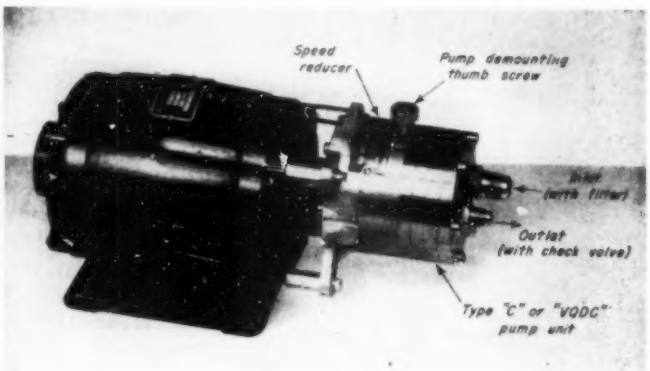
Type VQDC-132-W, quick demountable variable capacity pumps equipped with governor controlled variable speed motors are adjustable while running. These units with normal output capacities from 0.4 to 30 cc/sec, are powered with 1/25 hp, 60 cycles, 115-v, a-c universal motors, and are recommended for laboratory use or short-run operations. Type VC-132W is available in a rigid mounted pump. Overall dimensions for both are 4 x $5\frac{1}{2}$ x $11\frac{1}{2}$ in. Net weight is $10\frac{1}{2}$ lb.

Type VQDC-2412, quick demountable fixed capacity pumps, equipped with $\frac{1}{12}$ hp, 115 v, 60 cycles, a-c motors are available with various fixed speed transmissions for dispensing water capacities from 10 to 75 cc/sec (see graph). By restricting the discharge flow, the capacity of this unit may be throttled to 2 cc/sec, or a restricted by-pass from the discharge to the intake lines, will permit capacities to start from "0" cc/sec. These pumps are recommended for laboratory use or continuous production operation. Type C-2412 is available in a rigid mounted pump. Overall dimensions for both are $4\frac{1}{4}$ x $5\frac{1}{2}$ x $12\frac{1}{2}$ in. Net weight is 18 lb.

Specially designed to withstand steam autoclaving, quick demountable pump heads are available with the same driving units for biological work involving whole blood, plasma, vaccines, and hormones, sera, and other sterile solutions. From the stainless steel to the pure carbon used in constructing these pumps, only non-pyrogenic materials contact the liquids passing through. Pump heads for this


Micrometer adjustable speed control
Flared tube outlet fitting (with check valve)
Flared tube inlet fitting (with filter)
Type "C" or "VQDC" pump unit

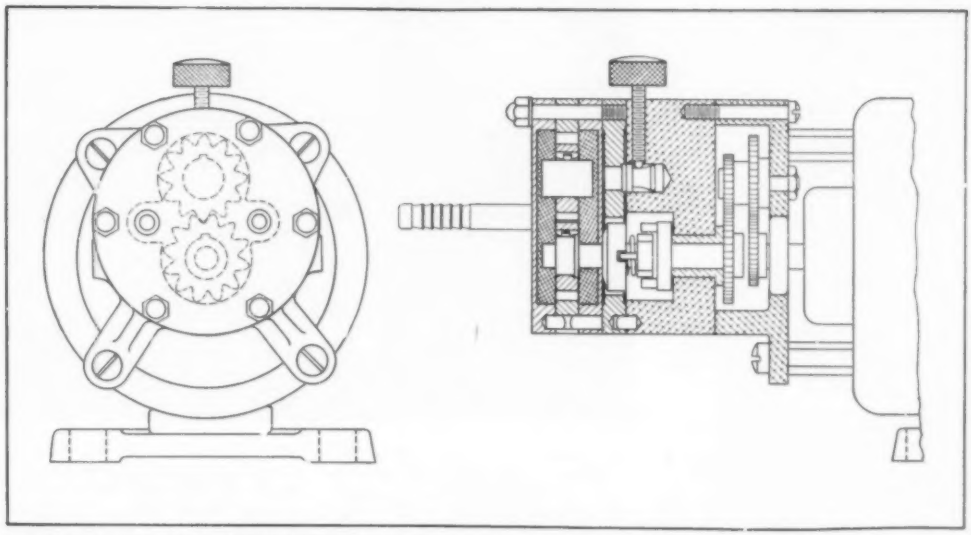
TYPE VQDC—5520-EM, variable capacity pump, equipped with variable speed transmissions. Output range is from 0 to 25 cc/second. Motor is $\frac{1}{8}$ hp, 115 v, 60 cyc. a-c.



TYPE VQDC—2412, fixed capacity pump. Motors are available with various fixed speed transmissions. Output range is from 10 to 75 cc/second. See capacity chart.

MATERIALS - PARTS

SPECIFIED BY PRODUCT ENGINEERS

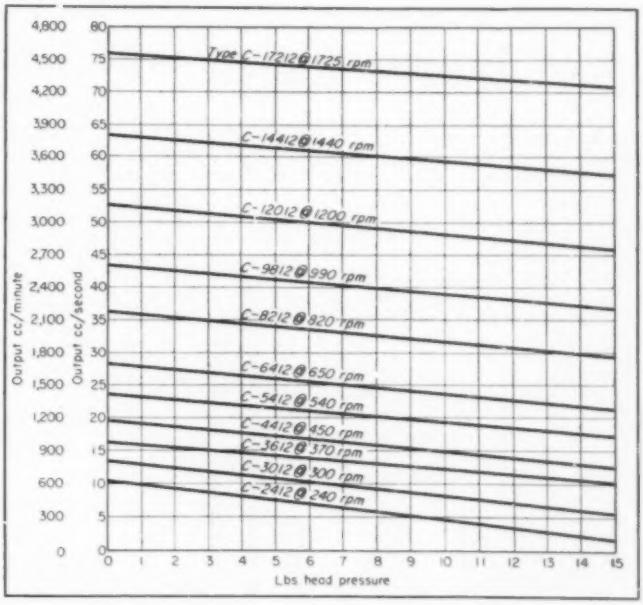


CUTAWAY VIEW OF METERING PUMP showing construction of the quick demountable pump head. All surfaces are metal to metal lapped surfaces, requiring no gaskets. The pump head is interchangeable on all fixed and variable speed drives.

work are designated with the code letters HQDC. Other pump heads have the code letters C or VQDC. All engineering details, involving selection of materials, design, construction, and operational functions relating to biologicals, pharmaceuticals and sterile solutions, were developed in cooperation with a Medical Research Organization who now use these pumps.

Other features of these pumps are: self lubricating oilless bearings, no gaskets, easily disassembled, non-pyrogenic materials used in pump units.

Mechanical Products Co., 168 N. Ogden Ave., Chicago 7, Ill.



THIS CAPACITY CHART applies to STD pump heads adapted to fixed speed transmissions driven by 1/12 hp motors, 115 v, 60 cycles, a-c. Pump heads, designated by prefix "C", VQDC and HQDC, are adaptable to, and interchangeable on, all standard speed reducers. Transmission speeds and motor hp are designated by numbers, 2412, 3012, 3612, etc. These numbers also identify rated fixed capacities. Water capacities are indicated, with gravity flow to pump intake. Capacities with viscous liquids are slightly higher.

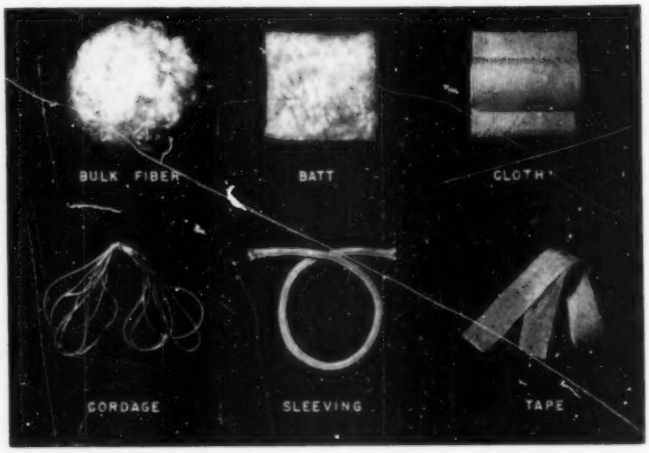
CONTINUED ON PAGE 210

Insulation Has Low Thermal Conductivity

A fibrous silica insulation called Refrasil, originally developed for installation in jet aircraft for protection against high temperatures, now is available for use as thermal and electrical insulation in various fields.

A typical new use of Refrasil material is that of sleeving as electric space separators in thermocouple leads. This sleeving may be applied with maximum effectiveness where temperatures up to 1,800 F are encountered. Its light weight and minimum bulk, as well as its flexibility, makes it particularly desirable for a specific insulation problem. Sleeving is available in many variations of sizes and lengths for slip-on installation. Flexibility of braided Refrasil is not affected by continued exposure to high temperature under normal operating conditions.

The essential physical properties of Refrasil are chemical resistance of pure silica and high temperature resistance. Refrasil batt has low thermal conductivity, effective acoustical insulation, fiber diameter of 0.00020-0.00040 in., specific heat of 0.19, nominal thickness of $\frac{3}{16}$ in., and surface density of 0.05 lb per sq foot.



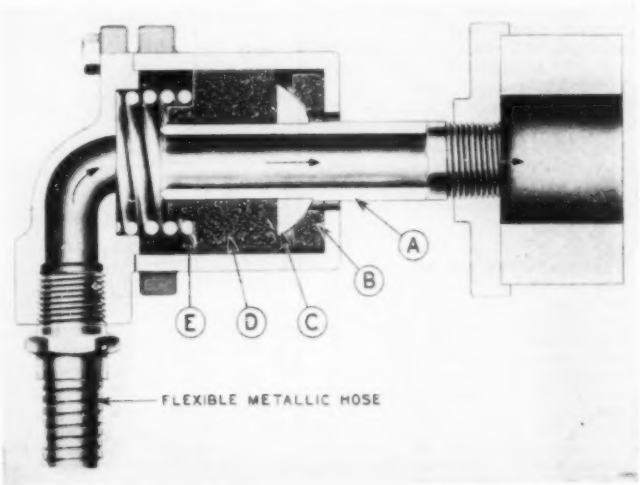
Refrasil is now being applied to, or has a potential use for: high temperature thermal insulation; electric space separators (thermocouple wire insulation); filtration of corrosive or high temperature materials; catalyst or catalyst support; ion exchanger; easily removed, flexible, long wearing insulation blankets; and plastic laminates.

H. I. Thompson Co., 1733 Cordova St., Los Angeles 7, Calif.

Pressure Joint Allows For Misalignment

New self-supporting joints are now available in heavy duty construction suitable for operating pressures up to 250 psi. This type joint is used in paper making, textile and rubber mills where heating and cooling agents must be admitted to rotating rolls, and where lateral movement is encountered.

The joints are packless, self-lubricating, and self-adjusting, with the rotating member consisting of one part—the nipple connected to the roll or drum. The parts, as shown in the photograph are: (A) nipple; (B) carbon graphite seal ring rotates against convex surface of nipple collar (C). Guide (D) supports joint. Spring (E) is for initial seating only. Pressure acts as the sealing force, filling the housing and forcing the seal ring against the collar. Available for through flow or syphon pipe service, sizes are from $\frac{3}{4}$ in. to 3 inches.



Johnson Corp., Three Rivers, Mich.

CONTINUED ON PAGE 212

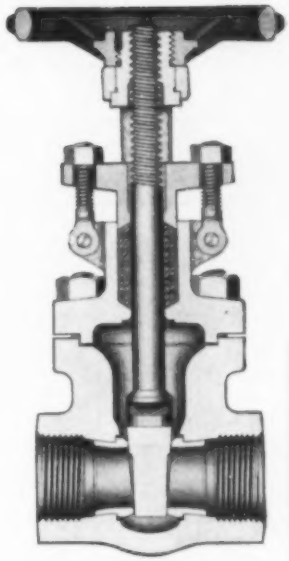
Helpful hint to piping specifiers ...check your CRANE Catalog first

Writing specs for this *Fuel Oil Pumping and Heating Unit* becomes greatly simplified when you reach for your Crane Catalog. In it you'll find the world's broadest line of valves, fittings, pipe, and accessories—all arranged for quick selection.

You get complete information about every item . . . all dimensions, tabulated pressure and temperature ratings, services for which each valve or fitting is best suited. In addition, there's a wealth of general engineering data to assist in solving problems that arise in designing piping systems.

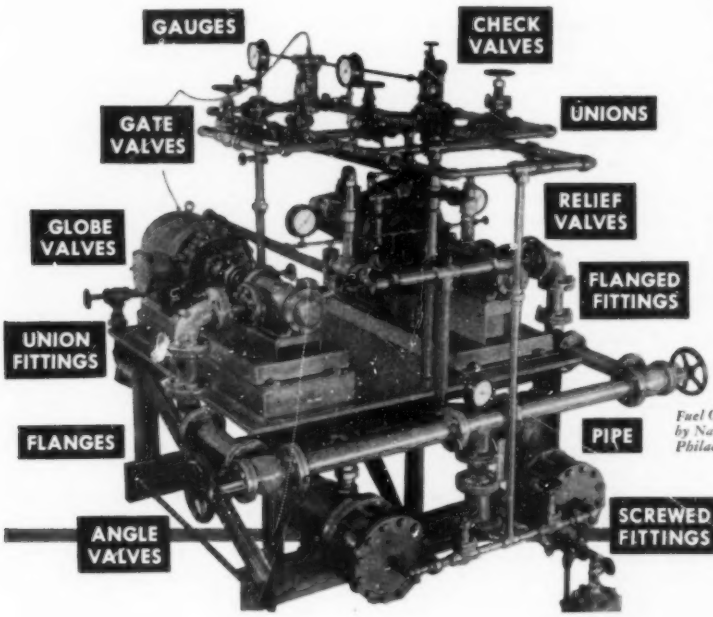
And not to be overlooked—*especially today*—is the added value Crane equipment gives your finished product. Machinery buyers know from experience that dependable Crane Quality stands for the best in piping materials.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



FOR OIL OR OIL VAPOR
services at temperatures up to 1000° F., and for most corrosive and unrefined oils regardless of temperature, Crane recommends No. 3607 X 600-Pound Small Steel Wedge Gate Valves. Exelloy to Exelloy trim. Bolted bonnet. O. S. & Y. Screwed ends. Sizes: ½ to 2-in. See your No. 49 Crane Catalog, p. 224.

FOR EVERY DESIGN . . . EVERY FLUID HANDLING PROBLEM . . . CRANE HAS THE PIPING EQUIPMENT YOU NEED



Fuel Oil Pumping and Heating Unit by National Airoil Burner Co., Inc., Philadelphia, Pa.

EVERYTHING FOR EVERY PIPING SYSTEM **CRANE**

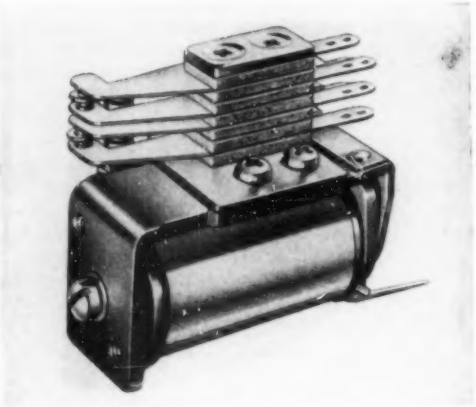
VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

Relay Combines Small Size With Sensitivity

This relay, known as the type *KX*, is a refinement of the small type *K* unit also produced by this company. The *KX* has increased sensitivity and operating range using the same small sized unit.

The new type *KX* provides a slightly longer coil than the type *K* which can be safely wound to a maximum resistance of 8,000 ohms. A slight change in the design and suspension of the armature permits this additional winding space without adding materially to the over-all length of the relay. The Type *KX* is interchangeable with the type *K* for mounting. It retains the reed armature suspension of a special alloy, thought by the manufacturers to be the reason for the improved performance.

Specifications: length, $1\frac{3}{8}$ in.; height, $1\frac{5}{32}$ in.; width, 1 inch. Dimensions vary with type of coil terminal used. Height shown is maximum (with 8 springs in pileup). Weight: approximately 2 oz. Coils: single or double wound. Operating voltage: to 175 v d-c. Armature: single or double arm.



C. P. Clare & Co., 4719 W. Sunnyside Ave., Chicago 30, Ill.

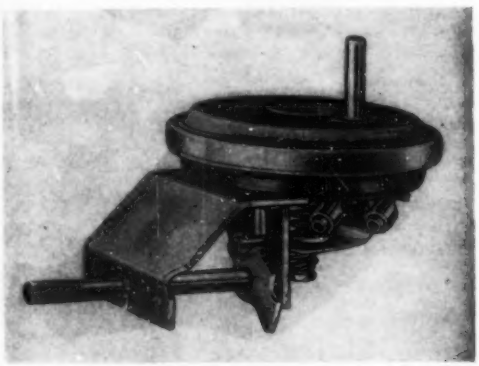
Air Pressure Actuated Electric Switch

For use where it is desirable to have differential air pressure control electrical circuits, an electric control switch has been developed which incorporates an actuating diaphragm with a rolling spring snap-action switch.

The movement of the diaphragm is opposed by a spring which can be cam adjusted to any one of three values of opposing force. Air pressure, admitted through a $\frac{3}{16}$ in. diameter inlet tube above the diaphragm is the loading force on this unit. The three cam settings result in switch actuation at 8, 9 or 10 in. of water. An adjustment is provided to vary these actuating pressures upward to 9, 10 or 11 in. or downward to 7, 8 or 9 in. of water.

This switch is now being used as a water level control in automatic washers, but it can be adapted to other uses.

The overall height of the unit is $3\frac{1}{4}$ in., length is $4\frac{3}{4}$ in., and the diaphragm case dia. is 3 in. The switch is single pole, double throw, rated at 10 amps, 115 v a-c.



Acro Mfg. Co., Columbus, Ohio

Three Way Valve Is Pilot Controlled

This three way pilot controlled valve is designed to control the alternate application and release of fluid pressure to and from equipment such as air or hydraulic cylinders.

When the solenoid of the pilot control valve, attached to the top of the main valve, is energized, line pressure reacts upon an internal piston that positions the bronze main valve to close the exhaust port (upper right) and open passage for flow thru the main valve from pressure side (lower right) to delivery side (left side). When the solenoid is de-energized, pressure supply to the pilot control valve is cut off and the main valve is repositioned to close the pressure supply port and connect the delivery port directly with the exhaust. Under controlled timing, this series of events can be repeated in automatic cycles.

These valves are suitable for handling air, gas, oil or any other non-corrosive fluid at temperatures not exceeding 180 F. Pipe sizes are 1 in., $1\frac{1}{4}$ in., $1\frac{1}{2}$ in., and 2 in., each with designs suitable for 125 and 250 psi operating pressure. Standard solenoids are for 115 or 230 v a-c or d-c and for 25, 30, 50 or 60 cycles. Other ratings available when required.

Automatic Switch Co., 379-D Lakeside Ave., Orange, N. J.

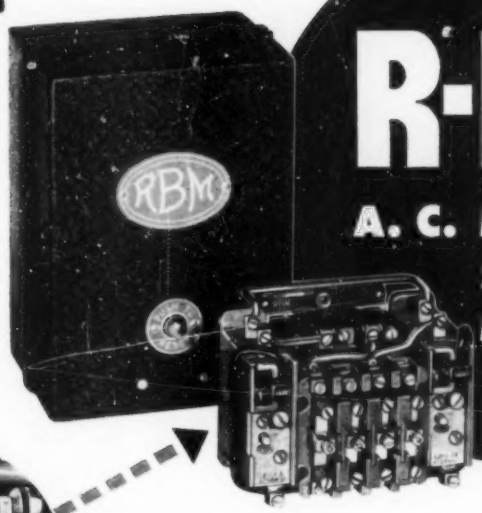
CONTINUED ON PAGE 214

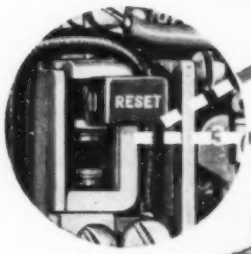
NEW!

R-B-M

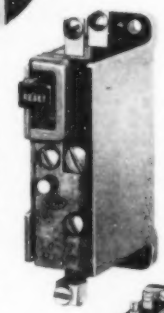
A. C. MAGNETIC STARTERS

Line Voltage Type





With Visible Contact Overload Relays

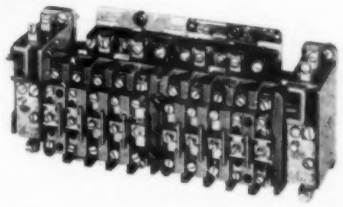


- Heater element cannot be assembled to starter incorrectly.
- Bi-metallic thermal overload relay assembly replaceable without removing starter from enclosure. Designed for separate mounting without sub-panel assembly.
- TRIP-FREE Manual reset is standard. Manual-Automatic Reset available on special order at no extra cost.

Two 5 pole contactors mechanically interlocked with overload protection on common base. Unwired. Note interchangeability of 25 ampere normally open contacts and 15 ampere convertible N.O. or N.C. interlocks.

R-B-M Size 0 and 1 A.C. Magnetic Starters have identical overall panel mounting dimensions. All parts, except stationary and movable contact assemblies, are common to both sizes.

Ilsco solderless lugs, suitable for #6 maximum wire size, are standard. Screw terminals are available on special order. Magnet coil can be removed without disassembling starter. Stationary and movable contacts replaceable without disconnecting wiring. Enclosed heater element, expanding U-shaped bi-metal and snap action contact mechanism provide dependable, accurate motor overload protection.



Small overall size, plus identical mounting dimensions for 10 and 15 ampere 2 to 5 pole contactors, as well as Size 0 and 1 non-reversing starters, make the R-B-M line extremely flexible for control panel layout.

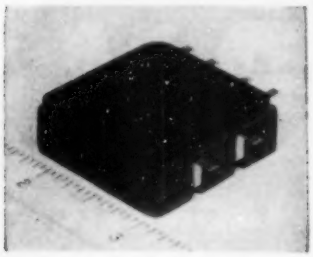
Address Department C-10

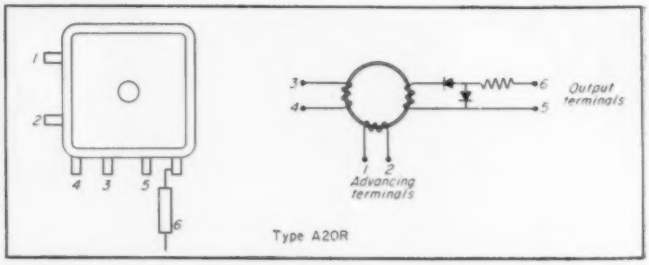
RBM

R-B-M DIVISION ESSEX WIRE CORP.

Logansport, Indiana

MANUAL AND MAGNETIC ELECTRIC CONTROLS — FOR AUTOMOTIVE, INDUSTRIAL, COMMUNICATION AND ELECTRONIC USE!





Magnetic Memory Requires No Motion for Signals

In addition to its use in large scale digital computers, this static magnetic memory has a variety of uses in such fields as: guided missile, electronic business machines, automatic controlling equipments and communication systems.

This device utilizes the residual magnetism of a magnetic material for storage, yet it requires no mechanical motion for read-in and read-out signals. It is provided with a special electrical coupling link so that a number stored in one unit may be shifted to another unit simply by the application of a small electrical pulse. The access time for this operation is 20 microseconds. It is under this operation that the unit is sometimes known as a magnetic delay line or a magnetic shifting register.

It has such uses as: storage of numbers and commands in digital computers; storage of controlling pulses in complicated controlling systems; serial-parallel transformation of signals; transformation of repetition rate of signals; counting of pulses; variable frequency division; generation of variable frequency and variable pattern timing pulses.

Wang Lab., 296 Columbus Ave., Boston, Mass.

Low Range Tester For Light Weight Materials

A multi-low-range tester has been designed to test light weight materials such as cloth, paper, springs, ceramics, adhesives, wire, leather, insulation, plastics, fibres and any material that will fall within its 300 lb range. These tests may be conducted in tension, compression, or shear.

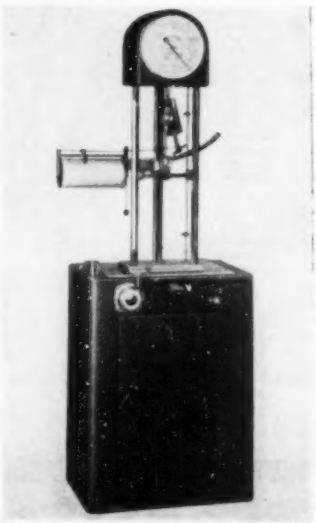
The tester operates by means of a calibrated pendulum. In use, a known weight is placed on the pendulum arm at a designated mark. The arm is attached to the mechanism shaft, and to the opposite end of this shaft a precision gage is mounted. As the load is applied the pendulum moves outward. A full scale reading is obtained with 0.196 in. downward travel of the grip. The pendulum is displaced a maximum of 35 deg of arc, making possible almost absolute linearity.

Four individual ranges are provided on the dial, with calibration being available in a choice of: ounces, tenths lb, and kilos. By breaking the gage into four scales, the operator can work in the range that will allow the closest readings. To change from one scale to another, it is only necessary to change the pendulum weights. These are slotted and slip on or off the pendulum arm easily.

The tester is provided with a pointer that indicates load as it is applied, and registers the maximum load when the specimen ruptures. This is accomplished through use of a series of small pawls on the end of the pendulum which rides over a ratchet face. When the break occurs, the pawls and ratchet engage.

For power drive, the unit uses a $\frac{1}{12}$ hp motor, operating on 110 v a-c, 50/60 cycles. It permits stepless draw bar speeds of from zero in. up to 20 in. per minute. Limiting switches prevent accidental overrun at top or bottom of test stroke.

Gripping jaws will handle flat specimens up to $\frac{1}{8}$ in. thick by $1\frac{1}{4}$ in. wide for tension tests. A cage arrangement for compression tests will accommodate specimens up to 3 in. sq by $4\frac{1}{2}$ in. tall, and will close to zero inches. The fixture for transverse tests will handle specimens up to $\frac{3}{4}$ in. round or sq and has 1 in. min, 3 in. max centers. Grips for wire specimens are available for sizes up to $\frac{1}{8}$ in. dia. Snubber post design assures correct break at center of specimen.



W. C. Dillon & Co., Inc., 1421 S. Circle Ave., Forest Park, Ill.

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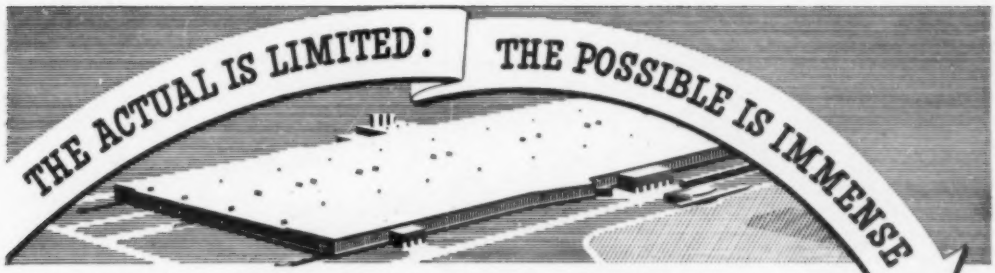


NEW LINCOLN PLANT CREATED BY INCENTIVE-INSPIRED CO-ACTION IN DEVELOPING POSSIBILITIES IN PRODUCT

© LE Co. 1951

STEEL DESIGN SAVES MATERIALS AND MAN-HOURS . . . CUTS COST 60%

WHEN a design utilizes the economies of welded steel, it can be produced for less cost because:

With welded steel, material costs are less. Only 50% to 25% as much metal is required. And, pound for pound, steel costs 75% less, giving an initial 7-to-1 cost benefit with which to start your designs.

With welded steel, fewer man-hours are needed for fabrication regardless of quantity produced. Smaller lots can be manufactured economically using simple tools. As quantities increase, designs can be modified further to replace some welding with bending, thus further reducing production costs.

Wherever costs with steel designs are higher, invariably the designs have fallen short of achieving the ultimate in savings possible with arc welding, or the products have been "over-designed." A restudy of every design by production engineers, before it becomes "frozen" for manufacture, helps eliminate costly details.

Your Lincoln Welding Engineer will gladly assist in analyzing your product requirements to cut costs.

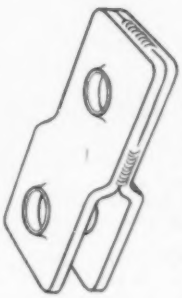


Fig. 3—Steel Stamping *from light gauge metal is formed in a die and welded. Weight is cut to 2 pounds . . . cost to 22¢ . . . a saving of 62% over Fig. 2. Saves 65% over Fig. 1.*

Fig. 4—Saves 16% Cost *over Fig. 2 by replacing tubing with simple U, formed from heat steel strap. Holes are prepunched prior to welding. Weighs 2¼ pounds . . . costs 49¢.*

Fig. 2—Uses Sheared Steel Strip *to cut 10% from production costs, as compared with Fig. 2. Requires only simplest of fabricating equipment. Weight is 3 pounds . . . costs 54¢.*

the ACTUAL

Fig. 1—Original Design. *Machine clevis weighs 7 pounds . . . requires drilling, boring, reaming and spotfacing operations. Costs $1.45 for material and labor.*

increasing the YIELD

Fig. 2—Welded Design Saves 60% Cost. *Fabricated from tubing and steel strap. Needs only fast, simple punching operation. Weighs 3¼ pounds . . . costs only 58¢.*

the IMMENSITY of the POSSIBLE

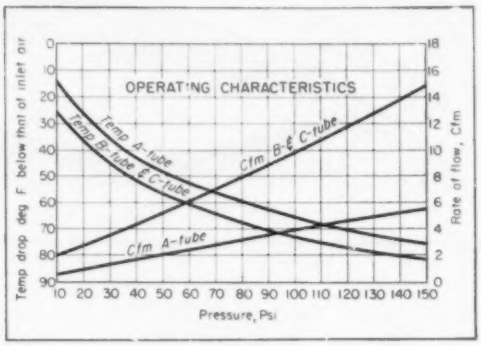
Lower Costs Regardless of Quantity Produced

SEE HOW STEEL DESIGN CUTS COSTS STILL FURTHER

Machine Design Studies are available to designers and production men. Write on your letterhead to Dept. 39,

THE LINCOLN ELECTRIC COMPANY

CLEVELAND 1, OHIO


OPERATING CHARACTERISTICS
Temp drop deg F below that of inlet air
Rate of flow, Cfm
Pressure, Psi
Temp A-tube
Temp B-tube & C-tube
Cfm B & C-tube
Cfm A-tube
0 10 20 30 40 50 60 70 80 90
0 2 4 6 8 10 12 14 16 18
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150

Cooling Device Requires No Refrigerant

Requiring no refrigerating mechanism, sub-zero temperatures are produced from a supply of compressed air or other gas released through these vortex tubes. The temperature of the air is controlled by the throttling valve at the right end.

The three models available are shown in the photograph. Model *B* is used mainly for industrial purposes. It has standard ¼ in. pipe threads for direct installation on machine parts. They can be used for cooling such instruments as: small rectifiers, electron tubes, photomultipliers, and in laboratory or research operations.

In the operation of the tube, the entering air or gas passes into a tangential entry orifice producing a vortex in the configured internal chamber. Energy distribution is such that with adjustment of the throttling valve, the heated fraction exists from the long arm while the cooled fraction, selected from the central mass of the vortex by a restricting diaphragm, emerges at the short arm. Maximum temperature difference is attained with the flow regulated to a division of approximately 70 percent hot, 30 percent cold.

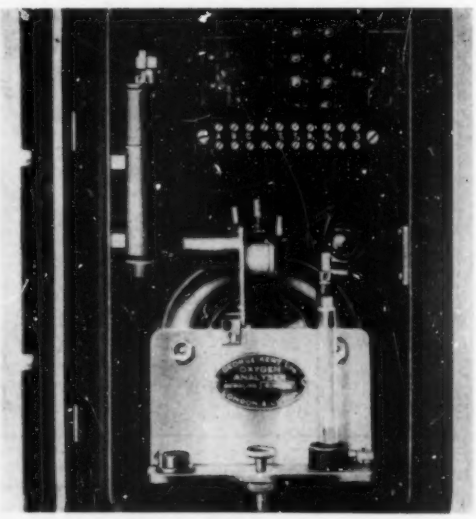
Thermo Instruments Co., 1181 El Camino Real, Belmont, Calif.

Magnetic Continuous Oxygen Recorder

A new paramagnetic continuous oxygen recorder has been developed for use in industrial processes such as the analysis of furnace atmospheres in the metallurgical industries, determination of the efficiency of the liquid air process of oxygen manufacture, and the oil and chemical industries.

The sample is induced through the filter by a water-operated aspirator fitted to the oxygen analyser. The sample gases are carried through pipes to a measuring cell—an annulus with a horizontal glass by-pass tube. This by-pass tube carries on the outside two identical, adjacent platinum windings which are joined in a Wheatstone Bridge circuit and become heated when a voltage is applied across the bridge. One of the windings only is traversed by an intense magnetic field from a large permanent magnet. When the gas sample enters the measuring cell, oxygen is attracted into the by-pass by the magnetic field. As it becomes heated by the winding it loses magnetic susceptibility, is displaced by cool gas, and passes along the bypass into the annulus. This continuous gas flow, or "magnetic wind", causes differential cooling, and thus differing electrical resistance, in the two windings on the by-pass, unbalancing the bridge. The resulting out-of-balance emf is measured by a recorder and is proportional to the oxygen content of the sample.

George Kent Ltd., Luton, Bedfordshire, England



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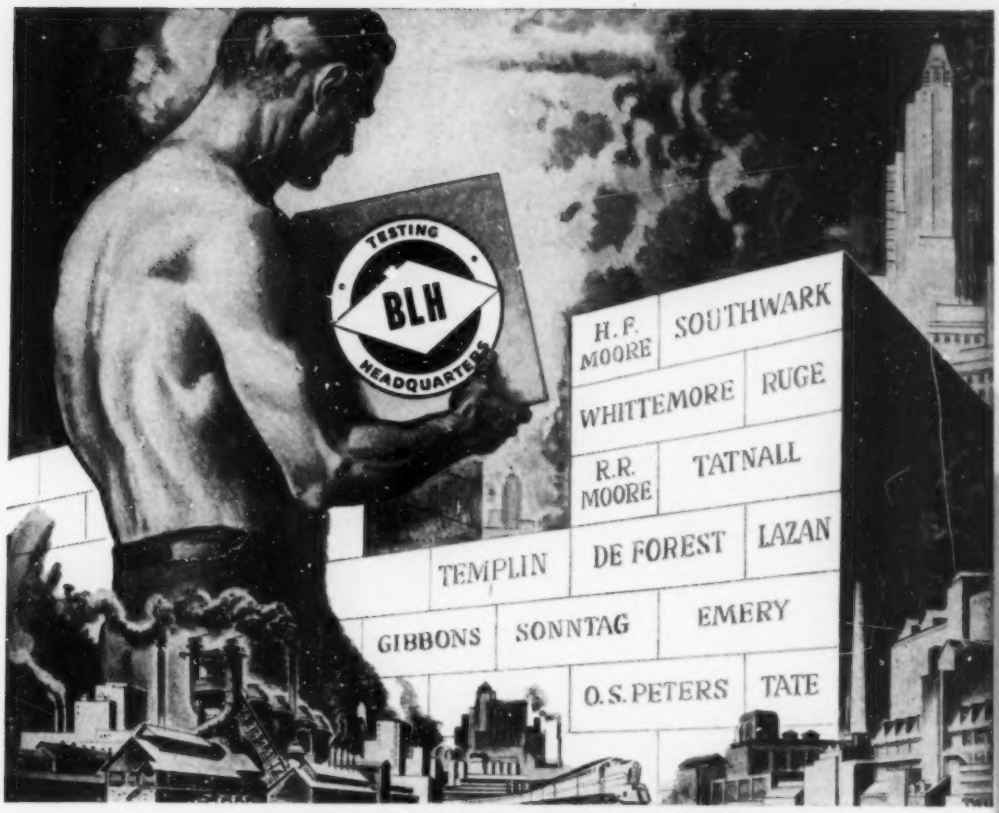

TESTING HEADQUARTERS
is built on a Foundation of FAMOUS NAMES

You know these names—for every one represents a major contribution to the science and art of materials testing. And every one has helped to make B-L-H Testing Headquarters the source of the newest in all varieties of fine testing equipment.

Over the years, Testing Headquarters has been a Clearing House for pioneering ideas, where every new development was sure of a welcome and a hearing. The results appear in such typical items as the line of fatigue testers, the versatile strain gage devices, the trail-blazing high-temperature testing equipment. Many of the most spectacular developments of the past decade rest squarely on the new, significant data provided by these new fact-finding machines.

Perhaps improvements in your present lines, or the development of new products are waiting on more accurate knowledge of the service properties of materials or components. If so, you will find it profitable to discuss the problem with one of our representatives.

If we don't have equipment ready to do the job for you, the composite experience behind these famous names is available to develop a right answer.

MORE FAMOUS NAMES AT TESTING HEADQUARTERS

YORGIADIS • NADAI
MANJOINE • BEAN • BLANKS
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NORTON • MONTGOMERY
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BEGGS • TROXELL • LUERSSEN
GREENE • JOHN • FLADER
NASON • TRIPOLITIS
SMITH • BIERMAN • LUBAHN

VISIT US AT BOOTH 311—BUILDING D
NATIONAL METAL SHOW

BALDWIN BLH LIMA-HAMILTON

BALDWIN-LIMA-HAMILTON
TESTING HEADQUARTERS

Eddystone Division • Baldwin-Lima-Hamilton Corporation • Philadelphia 42, Pa.

In Canada: Peacock Bros., Ltd., Montreal, Quebec

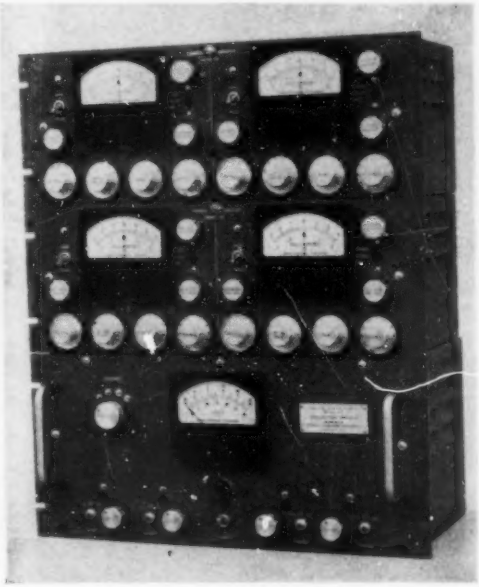
Amplifier Has High Gain Characteristics

Designed for making low level measurements from transducers of stress, strain, displacement, pressure, temperature, velocity, acceleration, and other parameters, this amplifier is intended for engineering, physical, medical, and other dynamic investigations. High gain characteristics are combined with low noise.

To permit flexibility of use, the equipment is housed in units which can be either mounted in standard 19 in. racks or bench-stacked as illustrated. One power supply (lower cabinet) will energize one or two 2-channel bandpass amplifiers (upper cabinets.) Tranducer inputs are brought to bridge circuits which are convertible for 1, 2, and 4 legged configurations as a convenience in summing or difference taking of transducer arrays through single amplifier channels. Bridges are of plug in thermally insulated design for quick interchangeability. To facilitate stress measurements, a special network provides readings from 120 ohm strain gages with calibration directly in terms of steel stress. Static zero drift of oscillograph traces is compensated through an automatic zero-control circuit.

Output frequency range for dynamic measurements of 0 to 500 cycles resulting from an amplifier passband 1,000 cycles wide (2,000 to 3,000 cycles) and flat to ±2 percent; carrier frequency is 2,500 cps; 6 ma output range; maximum sensitivity, 30 microvolt input for 1 ma output into 40 ohms; ambient temperature range, —10 C to 50 C; power, 115 v at 220 v-a for 4 channel operation.

Electronic Engineering Assoc., Ltd., 1068 Brittan Ave., San Carlos, Calif.

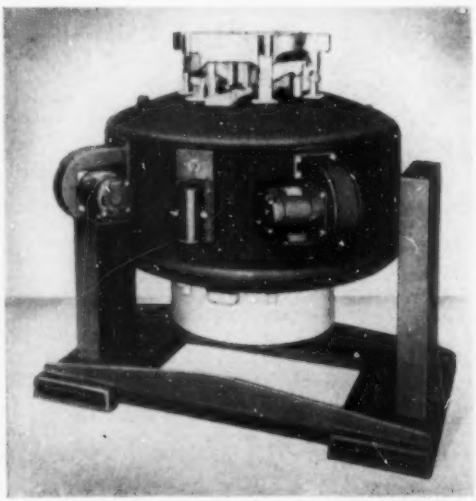


Vibration Exciter Tests to Military Specifications

Now in production is a vibration exciter called the model C-25 which has the capacity for meeting specification MIL-E-5272 and 41065B on vibration testing. Such testing is required for certain military equipment since it reveals in advance how products will stand up against vibration in service. The characteristics of this device are such that the magnitude, and frequency of the force produced can all be controlled over wide ranges, and allow direct measurement of the mechanical force and the power delivery. In these respects, the shaker differs from other devices used to shake or jar assemblies and parts. This shaker is rated at 2,500 lb force and is capable of accelerations 15 times that of gravity under 100 lb table load.

According to the manufacturer, this shaker features accurate, continuous, easy control of both frequency and force, with electrical interlocks to prevent improper operation of the equipment. The complete shaker weighs approximately 4,500 lb and stands almost 3½ ft high. The table has a 20 in. dia, and is shielded from a-c or d-c fields. No special mounting foundations are required. The complete equipment consists of exciter, 2-unit rotating power supply, and a control panel which is available with built-in meter to read vibration in terms of its acceleration, velocity and displacement.

The MB Mfg. Co., Inc., 1060 State St., New Haven, Conn.



CONTINUED ON PAGE 220

NEW CATALOGS AND BULLETINS

A Reader Service To Help Keep You Up-to-Date

(1) **SPROCKETS AND ROLLER CHAIN**—H. B. Sewall Mfg. Co. Catalog No. 51, 64 pp. Illustrations and cutaway views of various sprockets and roller chains. Also has complete list of specifications for all sizes, with hp ratings and type of duty recommended.

(2) **SPRING DESIGN**—The Newcomb Spring Corp. Bulletin NS 500, 8 pp. A 2-color reference guide called "66 Hints to Simplify Design and Reduce Spring Costs." Suggestions on how to eliminate complicated spring design. Hints grouped under 10 different headings.

(3) **RUBBER PACKINGS** — Raybesto-Manhattan Inc. Bulletin, 8 pp. Illustrations and specifications on various types of duck and rubber packing for all uses. Service recommendations given for each type.

(4) **VIBRATION MOUNTING FELT**—American Felt Co. Booklet, 18 pp. Tells how to select correct grade of mounting felt in booklet called "How to Reduce Vibration." Illustrations of sample installations.

(5) **SOCKET CAP SCREWS** — Holo-Krome Screw Corp. Catalog 51, 28 pp. Illustrations and complete specifications on socket set screws, cap screws, flat head socket cap screws, socket stripper bolts, and others. Additional information on key sets and dowel pins.

(6) **ELECTRICAL MEASURING INSTRUMENTS** — Westinghouse Electric Corp. Booklet B-4696, 20 pp. Illustrations and information on how to select electrical measuring instruments, giving seven basic selection factors. Instruments are illustrated, described, and functions of each explained.

(7) **COORDINATE GRAPH PAPER**—Orbit Electric Co. Bulletin, 4 pp. Describes use of the Dylewski arctangent coordinate graph paper, in scientific, mathematical, engineering, and statistical analysis. Allows uninterrupted curves of data having values ranging from plus to minus infinity.

(8) **FLOW RATIO CONTROLLERS** — Fischer & Porter Co. Catalog 51, 8 pp. Gives principles of operation of automatic flow ratio control systems. Includes isometric and schematic views of mechanism, sections of recording chart, and lists of typical applications.

(9) **STEEL TUBING**—Babcock & Wilcox Tube Co. Bulletin TA 1559, 8 pp. Technical data with illustrations on tubing for the petroleum, chemical, and other industries. Includes analyses and tables of physical and mechanical properties of 30 types of tube steels.

(10) **NYLON BALLS**—Ace Plastic Co. Bulletin NP-101, 2 pp. Gives complete information on nylon balls for valves, valve components, anti-friction bearings, mechanical checks and other applications. Resistant to chemical and abrasive materials, and high and low temperatures.

(11) **DIAPHRAGM VALVES**—Minneapolis-Honeywell Regulator Co. Specification Sheet 418-1, 4 pp. Detailed information on the air operated diaphragm motor valves for wide band proportional control. Contains illustrations, cutaway views, and operational curves.

(12) **GOVERNOR CONTROL PROBLEMS**—The Pierce Governor Co., Inc. Bulletin, 11 pp. Illustrations and description of the problems and applications of centrifugal governor control. Details on valve boxes, linkages, positioning of governor levers, and care and maintenance.

(13) **CHEMICAL SERVICE PUMP** — Warren Steam Pump Co., Inc. Bulletin WQ-213, 4 pp. Illustrations and specifications of the type G pump for process and chemical plants. Includes selection chart, dimension, external views and cutaway sections.

(14) **MOLECULAR SHOCK ABSORBER**—MVA Corp. Bulletin, 4 pp. Illustrations showing various types of molecular vibration absorbers. Theory of operation described, and possible applications listed.

(15) **SURFACE ROUGHNESS EVALUATION** — The Brush Development Co. Folder, 8 pp. Called "Surface Evaluation by Faxfilm", this folder describes the applications and process by which a plastic replica may be used to show roughness, grain, wear, and other surface conditions.

(16) **NICKEL STEEL SUBSTITUTES**—Republic Steel Corp. Adv. 571, 10 pp. Description and illustrations on the use of type 430 stainless steels as substitute for the nickel steels. Mechanical heat, and fabrication qualities given, with extensive details given to corrosion.

(17) **ISOMETRIC DRAFTING MACHINE**—Indamer Corp. Bulletin V-14, 8 pp. Contains illustrations and describes the operation of the Vibax, which automatically produces isometric and dimetric views by tracing over the lines of standard orthographic drawings.

(18) **CERROMATRIX FOR DIE MAKING**—Cerro de Pasco Copper Corp. Bulletin A-16, 20 pp. Completely illustrated, it describes the process of locating, blanking, piercing, and trimming punches in relation to dies. Shows how complicated holding devices are eliminated. Cerromatrix is an alloy of bismuth, lead, tin, and antimony.

(19) **ELECTRICAL CONNECTOR** — Albert & J. M. Anderson Mfg. Co. Catalog 49B, 8 pp. Describes and illustrates an interchangeable connector which eliminates the need for mating prong and socket contacts. Specifications and drawings for sizes of connectors used.

(20) **EXTRUDED PLASTIC TUBING**—Insulation Manufacturers Corp. Bulletin 310, 4 pp. Illustrations of application of plastic tubing for electrical leads and various types used. Complete specification chart with results of strength tests, corrosion tests and heat tests.

(21) **COPPER CLAD METAL**—Americas Cladmetals Co. Booklet, 4 pp. Entitled

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BUSINESS REPLY CARD

First Class Permit No. 64, (Sec. 34.9, P. L. & R.) New York, N. Y.

Reader Service Manager
PRODUCT ENGINEERING
330 West 42nd Street
New York 18, N. Y.

"Electroshield, the New Copper Clad Metal", it explains the use of a new metal offering copper savings of up to 50 percent. Gives physical, mechanical, and electrical properties, forms available, and applications.

(32) CONTROLS, PYROMETERS, RELAYS—Assembly Products, Inc. Catalog 1A, 36 pp. Listing of sizes, and ranges of contact meter relays, controls, pyrometers, panel meters, and relays. Technical data on descriptions and use of these instruments, together with illustrations, circuit diagrams, and installation and operating instructions.

(33) THERMOPLASTICS AND DIE CASTING—Tri-State Plastic Molding Co. Booklet, 8 pp. Illustrations and description of types of thermoplastics and die casting products made. Thermoplastics include styrene, lucite, tenite, vinylite. Precision casting of aluminum to 6 lb, and zinc to 13 lb.

(34) INFLATABLE STRIP SEAL—B. F. Goodrich Co. Booklet, 4 pp. Describes the new inflatable strip seal developed for the bubble-type canopies of military aircraft used in high altitudes. Contains blueprints of typical seal designs, inflated, and deflated, and engineering drawing of installation.

(35) LOCKING CLAMP — O'Neil-Irwin Mfg. Co. Booklet. Entitled "It's Easy to Bend", it describes the operation of the accessory for the Di-Acro bender known as the Quik-Lok clamp. Illustrations show installation and locking procedure.

(36) REINFORCED PLASTICS—General American Transportation Corp. Booklet, 12 pp. Illustrations showing phases of production of plastic and reinforced plastic parts, and the types and sizes of machines used. Contains lists of civilian and military products made.

(37) DIE PRESSED FORGINGS—American Brass Co. Booklet B-8, 12 pp. Comparative illustrations show what die pressed forgings are, and what can be done with them. Complete tabulation of copper and copper alloys suitable for forgings, with specifications of each.

(38) FLOAT CONTROLS—McDonnell & Miller, Inc. Supplemental Catalog, 20 pp. Illustrations, cutaway views, operation curves, and complete specifications on boiler water feeders, low water fuel cutoffs, make up water feeders for receivers, float operated switches, float valves, and flow-switches.

(39) PRINTING PRESS DRIVE CONTROLLERS—General Electric Co. Booklet GEA-5614, 4 pp. Describes features and applications of the new packaged a-c full automatic printing press drive controllers, designed especially for small daily newspapers in ratings from 40 to 75 hp. Contains complete press speed-time chart.

(50) MICA CAPACITORS — Cornell-Dubilier Electric Co. Catalog 420-421, 60 pp. Illustrations and engineering drawings on 93 types of mica capacitors for commercial, industrial, and military application. Contains characteristics, derating, dimensions, tolerances, extras or exceptions, and JAN unit designations.

(51) NICKEL RESISTANCE WELDING—The International Nickel Co., Inc. Bulletin T-32, 32 pp. Illustrated with drawings and photographs of welds. Curves on fatigue strengths of various metals. Tables on mechanical properties, chemical compositions, recommended conditions for welding and other information.

(52) MERCURY SWITCHES — Micro Switch, Inc. Catalog Hg-1, 4 pp. Covers five of the designs of the mercury switch, with selection and application aids, and complete electrical ratings and data for the use of these switches in both a-c and d-c applications.

(53) GENERATOR CONTROL SYSTEMS—General Electric Co. Bulletin GEA-5623, 8 pp. Deals with the 28 v generator control systems for multi-engined aircraft. Deals with centralized system and shows how protection is provided against over voltage, ground fault, reverse current, and undervoltage.

(54) VARIABLE SPEED CHANGER—Metron Instrument Co. Data Sheet 4P, 1 pp. Engineering drawing of the type 4E miniature variable-ratio speed changer. Linkages or cams give variety of applications including timers, recorders, controllers, computers, and indicating mechanisms.

(55) SPRAY NOZZLES—Yarnall-Waring Co. Bulletin N-617, 20 pp. Illustrated with engineering, and cutaway views of the involute nozzles for spray cooling ponds, and flat-spray nozzles for industrial processes. Also has operating curves.

(56) TENSION LOAD CELL—Baldwin-Lima-Hamilton Corp. Bulletin 329, 2 pp. Information on the Type F SR-4 tension load cell. Has no moving mechanical parts. Translates changes in weight or force into changes in electrical energy. Contains cutaway view, wiring diagram, and complete specifications.

(57) MANUAL STARTING SWITCH—Allen-Bradley Co. Bulletin 600, 8 pp. Detailed description of manual starting switch for fractional horsepower motors. Shows typical installations. Contains complete dimensional and engineering data, and gives features of each model.

(58) ADJUSTABLE SPEED MAGNETIC DRIVE—Electric Machinery Mfg. Co. Bulletin 4406 "ESC-1101, 20 pp. Explains operation of magnetic drive, and precision control with it. Completely illustrated with various installation applications. Extensive operational curves and wiring diagrams given.

(59) STEAM PURIFIER—The V. D. Anderson Co. Bulletin 100, 4 pp. Illustrations and engineering drawings of an internal type purifier designed to remove 100 percent impurities from vapor. Used in steam drums, flash tanks, evaporators, deoderizers, and packed towers.

(60) ELECTRICAL INSULATIONS—Insulation Manufacturers Corp. Bulletins 750 A-E, 2 pp each. Technical and application data on: varnished silk, varnished asbestos cloth, varnished glass cloth, silicone resin coated glass cloth and tape insulation, varnished paper, and varnished cotton base cloth and tape.

(61) PILLOW BLOCKS—W. A. Jones Foundry & Machine Co. Catalog 48. Illustrations and description of pillow blocks in sizes to take shafts 1 15/16 in. to 9 in. dia. Engineering data, bearing capacities, lubrication information, dimension drawings, types, and sizes.

(62) ELECTRIC MOTORS—Century Electric Co. Form 949, 4 pp. Complete list of squirrel cage induction motors type SC and SCH, wound rotor induction motor type SR-3 or 2 phase, d-c motors, repulsion start induction motors, split phase motors, gear motors. Specifications.

(63) CARRIER DIALING—Lenkurt Electric Co. Booklet E1D-P10, 16 pp. Description of the auxiliary equipment designed to add dial signaling channels to H-1 western electric carrier systems. Illustrated. Has allocation chart, circuit diagrams, transmission characteristics.

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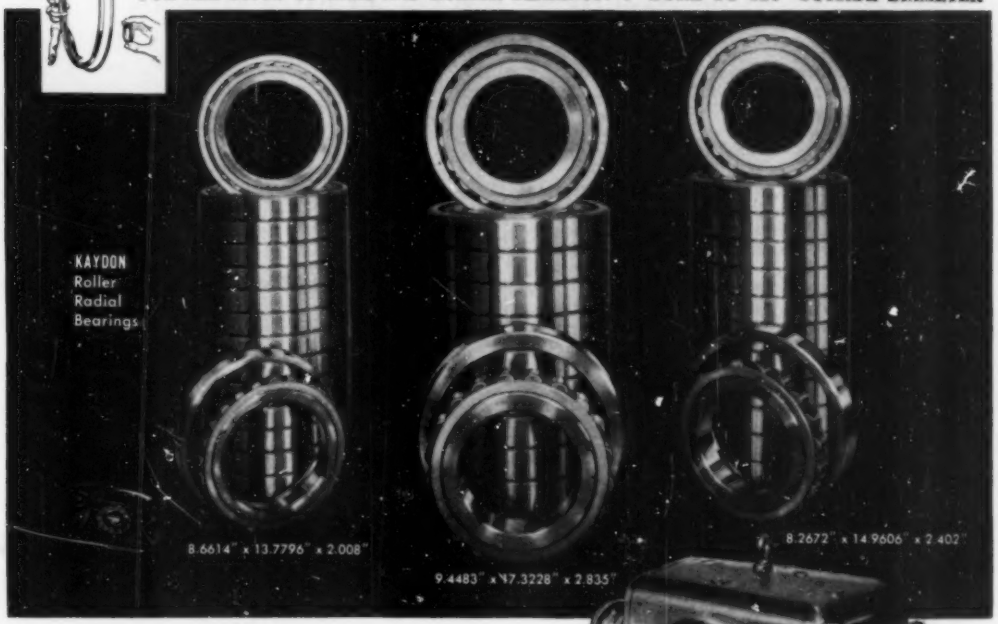
Contact KAYDON Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON and OILGEAR
cooperate for compact design

OILGEAR engineers, pioneering Fluid Power Pumps and Motors, achieved greater compactness and efficiency than ever before considered possible. KAYDON Engineers, pioneers in Thin-Section Precision Bearings, created bearings that were "right at home" at the high level of OILGEAR advanced design.

KAYDON Precision Bearings and Needle Rollers have helped many machinery builders achieve modern design with fewer parts, greater compactness, reduced weight, precision smoothness in operation . . . advantages that improve production, cut costs, and carry impressive sales appeal.

This exploded view shows KAYDON Front and Rear Roller Rotor Bearings with relation to other parts of the 150 hp OILGEAR Fluid Power Variable Delivery Pump (above) for machinery with operating-pressures up to 3000 pounds per square inch . . . with smooth, quiet, startlingly new fluid power performance characteristics. KAYDON Bearings are used also on 60 hp and 100 hp OILGEAR Fluid Power pumps.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

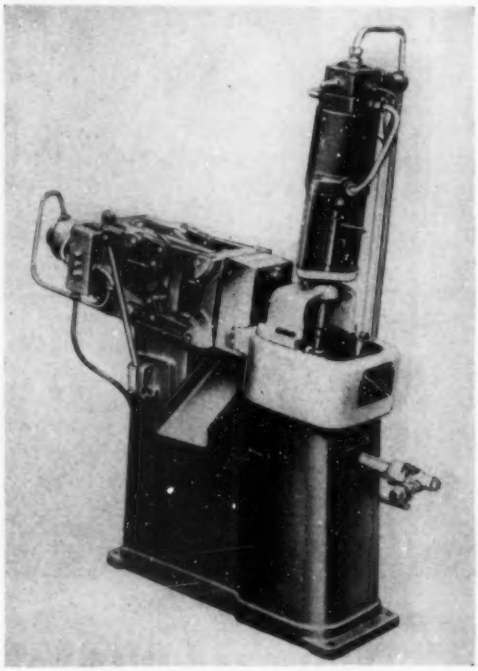
Die Casting Machine Exerts High Pressure

The new model IMP-96 one lb die casting machine has a pilot operated impact type injection cylinder with a slide valve in the head, controlled by a finger light trip lever. A safety interlock valve is employed to prevent metal injection before the dies are fully closed.

Also incorporated is the new double toggle air-operated die unit or large capacity and locking load. These developments mean that higher pressures can be exerted on the molten metal from normal airline pressures (80-100 lb) thus giving more uniform and homogeneous castings. Furthermore, the manufacturer claims that larger and heavier castings can be produced more easily than by previous methods used by this company.

The IMP/96 operates on a standard 80 psi airline and consumes only 0.55 cu ft of free air per cycle of operation. Additional information on this and other machines may be obtained from the manufacturer.

DCMT Sales Corp., 164 Duane St., New York 13, N. Y.



Specifications

Pressure on Metal with 1½ in. dia plunger	1,620 lb
Air Pressure	80 lb sq in.
Air Consumption per cycle	0.55 cu ft free air
Size of die plates	9 x 6 x 1½ in.
Die Opening	4 in.
Toggle Die Locking Pressure	12 tons
Casting Capacity	12 oz
Maximum Area of Casting	12 sq in.
Standard Diameter of Plunger	1½ in.
Space between Tie-bars	6½ in.
Pot Capacity (zinc)	45 lb
Floor Space	30 in. x 12 in.
Weight (net)	450 lb

Electric Printer Records Testing Machine Data

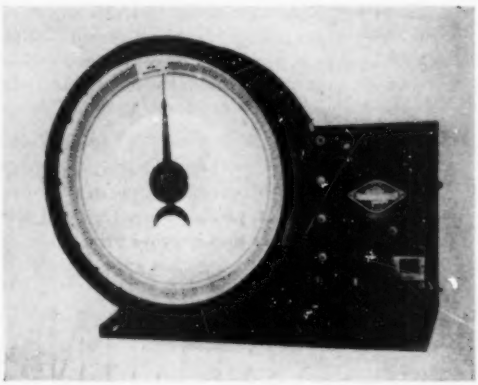
A new electric indicator and printer is now used with devices for measurement of displacement, force, weight, and pressure. This offers a card for permanent records.

The unit is completely self contained and is intended primarily for use with any of the commercially available low resistance strain gage measuring or sensing devices.

The printer being electrically operated can be controlled remotely or automatically to reduce manual work or time. With continuous timers, weights or loads can be recorded regularly without attending personnel. To eliminate errors due to weighing before proper balance is reached an attachment can be provided to prevent printing unless proper balance point has been reached.

A 60 cycle a-c system is used which does away with standard cells and standardization and makes it possible to totalize 2 to 4 input signals. The input signal is indicated on a large 20 in. diameter dial and recorded on a card.

Capacities of these indicators range from 100 lb to 500,000 lb with 1,000 division for each on indicator and printer. The accuracy is about 0.2 percent of capacity overall. For speed, the instrument will attain full scale in 6 sec, 12 or 24 sec for oscillating loads or measurements.



Gilmore Technical Assoc., 5511 Euclid Ave., Cleveland 3, Ohio

CONTINUED ON PAGE 222

LASTS TWICE AS LONG ...STILL GOING STRONG

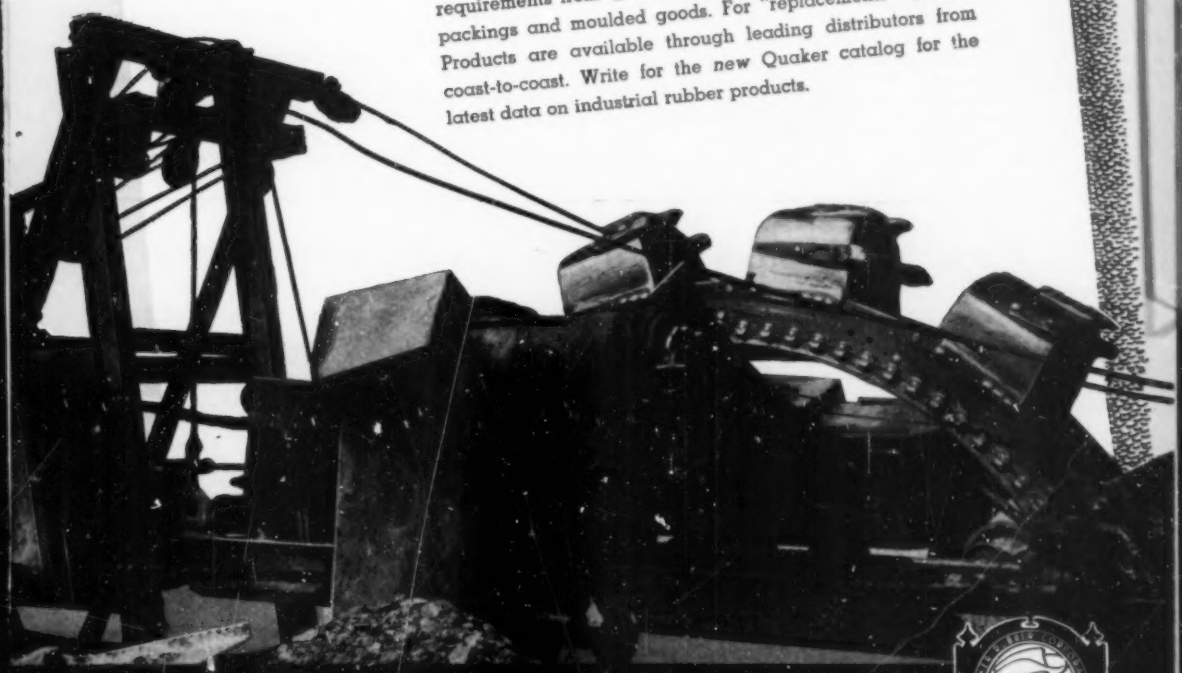
QUAKER CONVEYOR BELTING

LASTED LONGER THAN ANY OF SIX OTHERS

A "belt-killing" drive on a well-known trench digging machine was wearing out conveyor belts in a matter of weeks or months. Then a Quaker "Pre-Tested" Conveyor Belt was installed. Result . . . belt lasted almost twice as long as any of the six different belts used . . . still going strong . . . in fine shape.

Performance records like this and thousands of others are making more and more design engineers specify Quaker Industrial Rubber Products as original equipment.

Quaker sales engineers can assist you in producing a new rubber product . . . or applying an existing one to meet your requirements from Quaker's complete line of belting, hose, packings and moulded goods. For "replacements" Quaker Products are available through leading distributors from coast-to-coast. Write for the new Quaker catalog for the latest data on industrial rubber products.

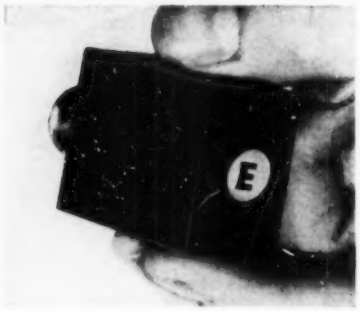


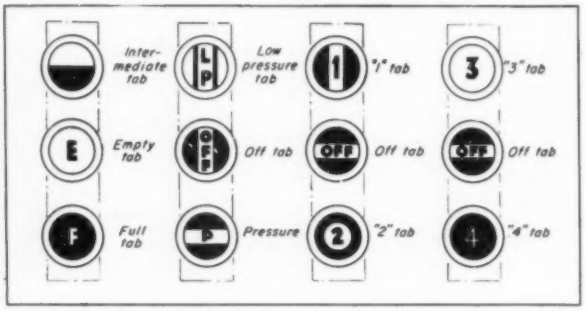
QUAKER RUBBER CORPORATION

DIVISION OF H. K. PORTER COMPANY, INC.

PHILADELPHIA 24, PENNA. BRANCHES IN PRINCIPAL CITIES

Solenoid Operated Three Position Indicator





A remote reading 3 position indicator has been developed for applications in mechanical, electrical, fluid, and air systems. Operating in much the same manner as the aircraft landing gear position indicator on which it is based, the new device consists fundamentally of a rotating card which exhibits one of three printed symbols at a round observation window ½ in. in dia in one end of the instrument. The card is rotated by two solenoids which draw it up or down to either of two extreme positions. When neither coil is energized the spring-balanced cylindrical card returns to neutral position, exhibiting the third symbol. Solenoids that control the indicator card can be actuated by any of a variety of commonly used float, pressure, or contact switches.

Used in aircraft as landing gear position indicator, and for reporting of de-icing fluid level and cabin air pressure, it may likewise be used to report pressures in factory hydraulic or air circuits, and to maintain checks on levels of lubricating oil, coolant, chemicals, or other liquids held in reservoirs.

The indicator body is compact (slightly larger than a cigarette lighter), weighs slightly under 2¾ oz, and is built to function under unusually adverse physical conditions. The sealed brass case is impervious to dust and dirt, and will pass salt-spray and immersion tests. It can be filled with inert gas if required. The unit withstands high-low temperature tests from —85 F to +158 F, and will pass vibration tests of 0.018 in., 0.020 in. amplitude between 300 and 3,000 cycles per min, as well as 4 hr cyclic thermal shock tests.

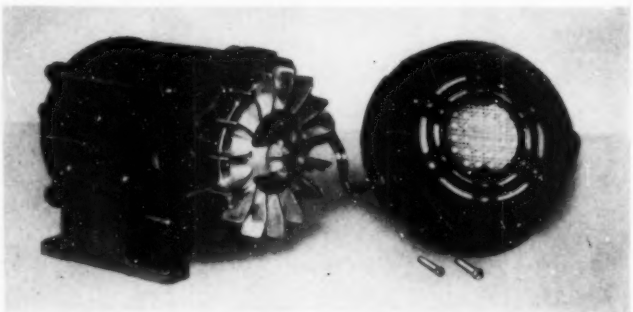
Symbols on the card can be designed to meet requirements of the job. Chart suggests possible designs. Characters can be applied in bright colors, or luminous paint for observation under poor lighting conditions.

Riverside Metal Co., Riverside, N. J.

Capacitor Motors With Fan Cooled Construction

Features of these new Tri-Clad single phase capacitor motors are: totally enclosed fan cooled construction, starting capacitors, and a switch mounted within the frame to provide maximum protection with the minimum space requirements. A view of 1½ hp, 1,800 rpm motor with fan housing removed is shown in the illustration. The motor provides easy accessibility for maintenance.

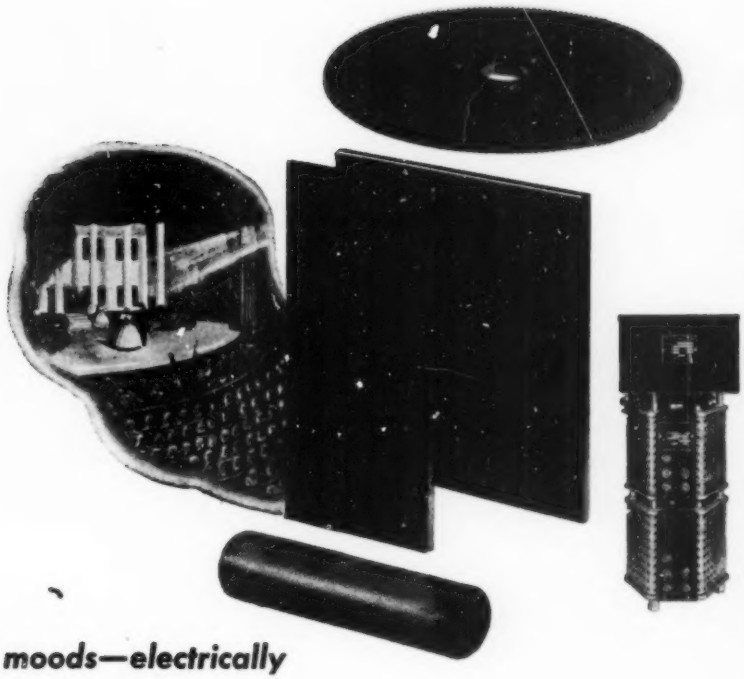
With ratings of 1, 1½, 2, 3 and 5 hp, this type of motor was designed for use where severe conditions of dirt, grit, or moisture are encountered. Typical applications are: coal stokers, exhaust fans, grain elevators, and fuel pumps.



The motors have cast aluminum squirrel cage rotors and are equipped with ball bearing mounting. Except for the 5 hp size, which operates on 230 v supply only, the motors operate on 115/230 v, 60 cycle power supply.

General Electric Co., Schenectady, N. Y.

CONTINUED ON PAGE 224



How to manage moods—electrically

The parts enlarged in the illustration above are a drive gear, a shaft, and panels used in the many types of Superior Electric Company *Powerstats*.

These parts have one characteristic in common. They are all made from Synthane, a laminated plastic.

Superior selected Synthane for its *combination* of properties. Synthane is dielectrically and mechanically strong, easy to machine, and is attractive in appearance. The panels are easily printed at a saving over engraving cost; the gear is silent.

A *Powerstat* is a manager of moods. Installed in the lighting systems of theatres, salons, banks, and other places of business and recreation, a *Powerstat* controls the intensity and blending of light to help create any mood from the spectacular to the subdued, from reverence to revelry.

Synthane is made in many grades, each particularly desirable for some electrical, chemical or mechanical purpose. Yet each grade possesses a *combination* of other valuable characteristics. Light weight, mechanical strength, resistance to moisture, corrosion and abrasion, high dielectric strength, low power factor, dimensional stability under a variety of conditions, and ease of fabrication are just a few of them.

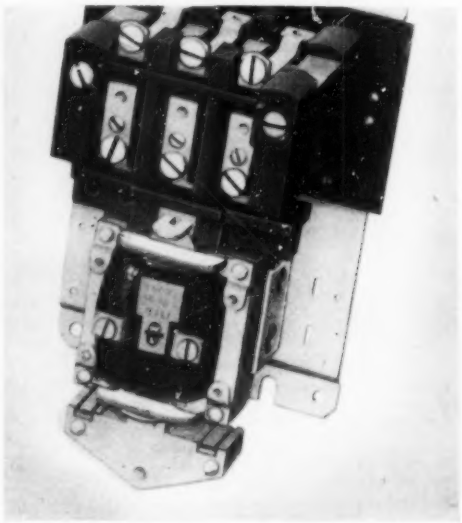
Should these properties of Synthane suggest a possible application to you, write for more information. Synthane Corporation, 3 River Road, Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE

Manufacturers of laminated plastics

Multi-Pole Solenoid Contactors for Controllers



New compact multi-pole solenoid contactors have been designed for both load and control circuit use in controllers for machine tools, refrigeration and air conditioning equipment and similar control applications. Features include: multi-pole unit construction, double break silver contacts easily converted to N.O. or N.C. contacts, a-c or d-c power plants, solenoid-operated and complete accessibility of parts.

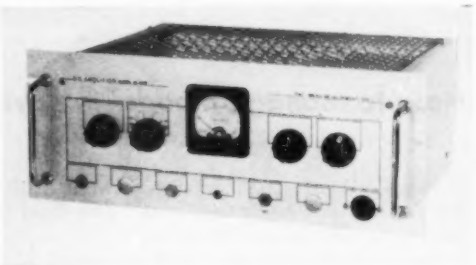
Contactors are available in 3 and 5 pole forms. The contacts housed in a molded melamine arc hood can be quickly interchanged to form N.O. or N.C. poles. A maximum number of 3 N.C. poles can be obtained.

Size 0 contactors can be furnished with d-c power plants for 115 or 230 v d-c operation. Mounting plate dimensions are identical with a-c types.

Maximum hp ratings are 2 hp, 440-550 v, 3 ph 60 cycles. Open 8 hr amp rating is 15 amp. Standard coils are available for 110, 220, 440 and 550 v operation on 25, 50 or 60 cycles.

Ward Leonard Electric Co., Mount Vernon, N. Y.

Amplifier For Direct Writing Oscillographs



A new direct coupled amplifier has been designed for use with the magnetic direct writing oscillographs also produced by this company. Studies can be made of conditions such as strains displacements, pressures, light intensities, and a-c or d-c voltages or currents.

Voltage gain of the instrument, approximately 1,000 times, is sufficient to give one millimeter of deflection on the oscillograph chart per millivolt input. Effects of power line fluctuation are minimized by design features combined with both plate and heater voltage regulation. Zero signal drift amounts to not more than one chart millimeter per hour. When the amplifier is used with the penmotor, the frequency response is essentially linear from d-c to 100 cycles per second.

The control panel on the face of the unit contains an attenuator with five factor-of-ten positions, gain control, calibrating meter, and controls for determining input voltages. A balancing potentiometer is provided for electrically biasing the oscillograph pen to any position on the chart. Input jack and output sockets are located on both the front panel and the rear of the chassis. The amplifier was designed for use on a standard 19 in. rack.

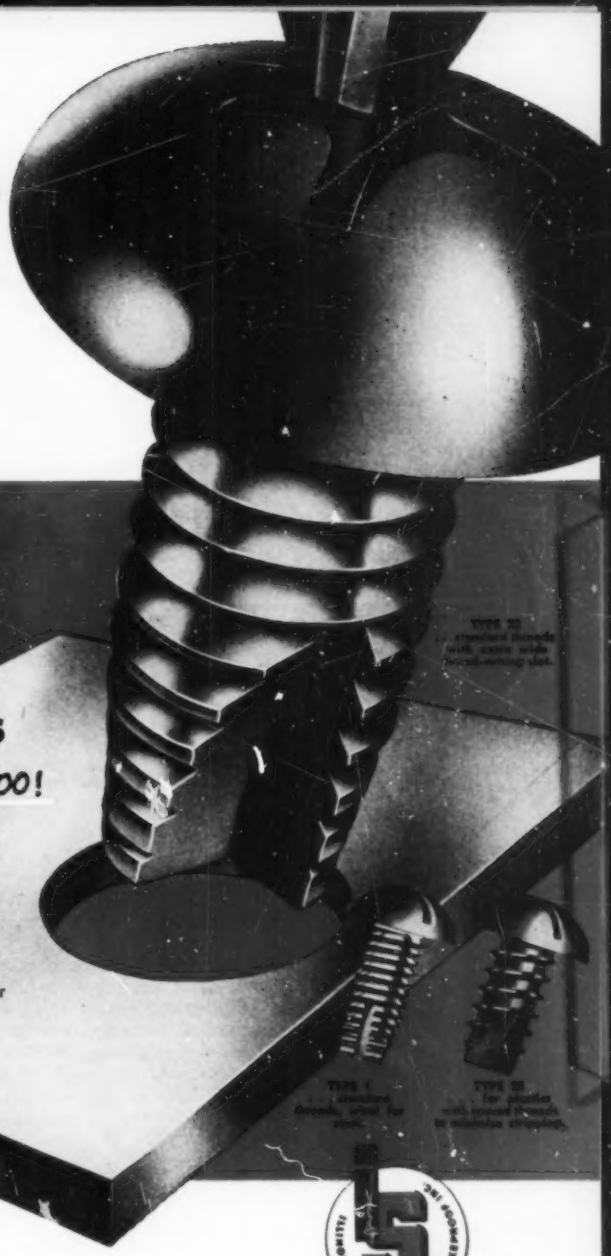
Brush Development Co., 3405 Perkins Ave., Cleveland 14, Ohio

REPLACING THE METHOD OF insulating audio transformer coils with varnish, the application of rubber sleeves is said to speed up transformer production. Development of the device was possible because of the dip process method of manufacturing which permits formulation of hollow, odd shaped rubber components to specified dimensions. The rubber compound used is neoprene because of higher heat resistance. Dewey & Almy Chemical Co., Cambridge, Mass.

A PHOSPLATE COMPOUND CALLED ANCHORITE 100 has been produced for the treatment of metallic parts that are resistant to corrosion, or as a base for painting. Its greatest use is with ferrous parts, but is being used as a prepainting treatment on such metals as zinc, galvanized iron, and cadmium. The solution is made by mixing the Anchorite with water and is applied by the immersion or spray method. This compound meets the specifications for a Class C (type II) finish in the U. S. Army Specifications. Octagon Process, Inc., 15 Bank St., Staten Island, N. Y.

CONTINUED ON PAGE 227

Why tap?



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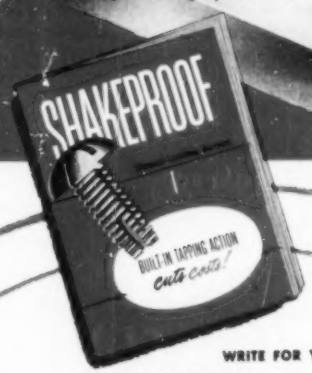

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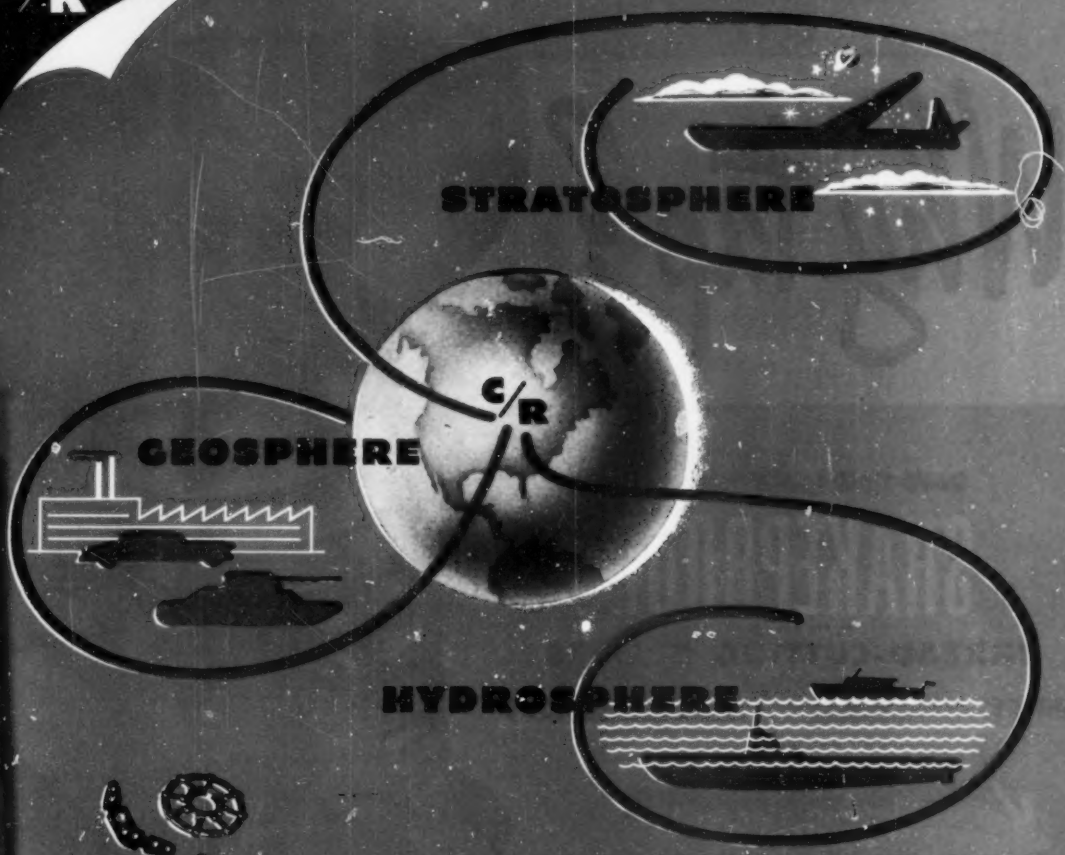

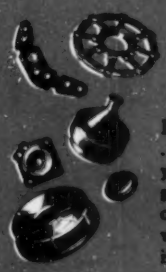

In whatever medium your mechanism operates . . . land, sea or air . . . Sirvene will best solve your pliable parts problem with a tough, new gasket, boot or diaphragm. Working from your own specifications, Chicago Rawhide engineers will make the needed design—regardless of "near-impossible" demands—and mass produce your part from scientifically compounded elastomers (synthetic rubber.)

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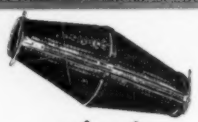
CHICAGO RAWHIDE MANUFACTURING CO.
1299 Elston Avenue **SIRVENE DIVISION** Chicago 22, Illinois



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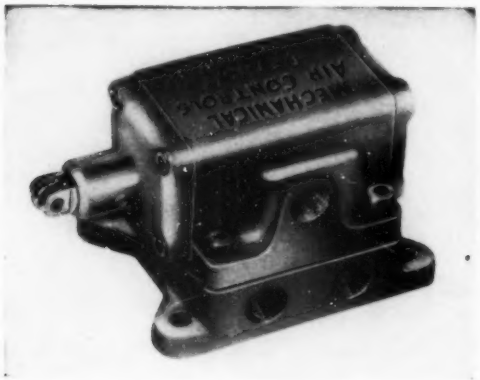
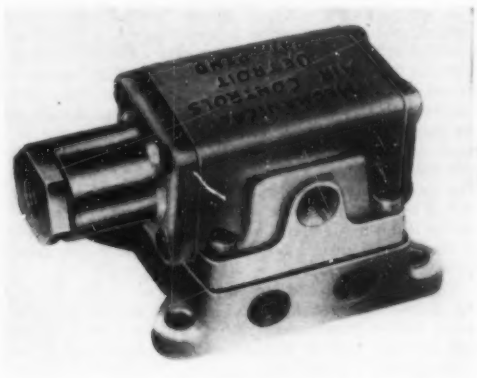
Air Valve Retainers Are Interchangeable





To a line of air valves has been added cam operated, and air pilot pressure operated valves. These types are available in the $\frac{3}{8}$ in. and $\frac{3}{4}$ in. sizes for straightway, 3-way, and 4-way applications up to 150 psi air pressure.

Featured is the interchangeability of the retainer or end cap construction for the selection of type of control. Removal of four cap screws from a basic valve assembly allows choice of operation by cam, pilot pressure, foot, solenoid, or hand.

The valves have bronze bodies and retainer caps with bores that are lapped to a micro finish and then hard chromed. Special "O" ring type seals mounted on an aluminum alloy piston give positive seal when they come in contact with their respective body bores.

Fast reversal of the valve is accomplished by the direct control action of the aluminum spool which is the only moving body assembly part. All types are in accordance with J.I.C. specifications and have cast iron sub-bases.

The cam and air pilot pressure control valves can be arranged for double cam control, double pilot control, or single control with spring return. All valves have full pipe size orifice areas with a maximum of straight through flow.

Mechanical Air Controls, 15511 W. 11 Mile Rd., Royal Oak, Mich.

Time Delay Generator Has Five Ranges

The model A-4 Time Delay Generator, a device for producing variable time delays ranging from 10 microseconds to 10 seconds, is particularly useful in the SONAR, geophysical, and biological research fields. It may be used for measuring unknown delays, generating a delay for the simulation of SONAR range, providing delayed sweep for synchroscopes or measuring wave forms. Five delay ranges are provided, giving a full scale reading of 0.001 sec delay on the lowest range, and progressing by decade steps to the highest range of 10 sec. Blocking oscillator and single shot vibrator output wave forms are provided.

The specifications include a linearity of 0.3 percent, or better between 1/10 scale and full scale, and accuracy after calibration of 0.1 percent and 1 percent long term. Incremental delay is limited by the resolution of the helical potentiometer control of 1/13,500 of full scale. The blocking oscillator output pulse is 0.5 microsecond wide with a rise time of 0.1 microsecond. The multivibrator output pulse is presented through a low impedance cathode follower and is designed to permit each viewing on the screen of a synchroscope; its width is a function of the delay range in use. The unit is mounted on a standard

relay rack panel, and the cover is stainless steel with oak end frames. Weight is 47 pounds.

Rutherford Electronics Co., 3707 S. Robertson Blvd., Culver City, Calif.

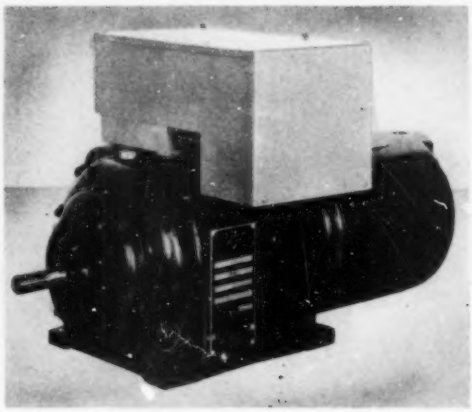
CONTINUED ON PAGE 228

Remote Control for Variable Speed Transmission

A new packaged system of remote electrical control for variable speed transmissions in sizes from 1/12 to 5 hp provides accuracy of speed setting over a complete range from the maximum speed desired to zero. The control is mounted on the transmission with only four bolts and may be added to the standard control of drives already in the field. The control is furnished with a switch for remote mounting to increase or decrease speed and is available with or without a speed indicator at the remote point. The speed indicator can be calibrated so as to read directly in feet per min, lb per hr, gal per min, or any other calibration that is desired for the particular application. Changes in the speed setting can be made with the transmission running or stationary.

The electrical control can be had on all models including mechanical reversing types as well as non-reversing drives and on transmissions with or without built-in motor and on drives with or without built-in reduction of either helical or worm geared types.

Graham Transmissions Inc., 3754 N. Holton St., Milwaukee 12, Wis.



Tension or Tractive Loads Measured Remotely

A new device called the Tens-O-Trol system has been designed for the measuring of tension, weight, or tractive loads remotely. It is electro-mechanical in design and is equipped with over size selsyn motors for added torque and dependability.

To the standard traction dynamometer produced by this company has been mounted a heavy, rubber covered cable to a repeater motor housed in a metal cabinet. When a switch is thrown on the front of the cabinet the system becomes operative. Loads imposed on the dynamometer transmitter are read on a repeater station at distances up to 400 ft away. The electrical circuit has been designed in order that various lengths of cable may be used interchangeably without affecting calibration. Aircraft type sockets provide secure connections. Two repeater stations may be used with each transmitter.

Other specifications: 12 v d-c, which is supplied by a dry battery is used; 12 different capacities from 0-500 lb up to 0-50,000 lb; the dial is 6¾ in. dia; cabinet is 9 in. wide by 11¾ in. tall; weight of transmitter is 9 lb, weight of repeater station is 12; guaranteed accuracy is 2 percent plus or minus full scale reading.

W. C. Dillon & Co., 1421 S. Circle Ave., Forest Park, Ill.

NEW POSITIVE GRIP music wire retaining clips may be assembled and removed without special tools and with no damage to the clips. Clips can be re-used. Available in standard designs or special designs to order, for shafts from ⅛ to ¾ in. diameter. Connor Spring Mfg. Co., 230 Natoma St., San Francisco 3, Calif.

A NEW LINE OF VITREOUS ENAMEL POWER RHEOSTATS will be available in seven sizes, ranging from 50 to 500 watts. They will be interchangeable, but will feature a hinged contact arm which is said to insure long life and freedom from burn outs. P. R. Mallory & Co., Inc., 3029 E. Washington St., Indianapolis, Ind.

A SPARK PLUG INSULATOR has been developed to waterproof the electrical system of all gasoline motors. It is said to prolong the life of battery, coils, condensers, points and distributer. Of neoprene composition, it will fit any standard spark plug 10 mm to ⅞ inches. Sealtight Corp., 219 Third Ave., S. W., Cedar Rapids, Iowa.

CONTINUED ON PAGE 230

CIRCUIT BREAKERS GIVE REPEAT PROTECTION

Nothing to Burn Out
Nothing to Replace

Use Square D's Thermal—Magnetic Circuit Breakers on ALL lighting and power circuits for these additional advantages:

Complete Protection • THERMAL element responds to heating effects of both load current and surrounding atmosphere. TOTAL temperature is limited to a safe value. MAGNETIC element responds instantly to heavy overloads or shorts. Both are needed for complete protection.

Downtime Minimized • Nothing burns out. No live parts exposed. Can be quickly reset by ANYONE.

Non-Tamperable • Factory test-tripped and sealed. Guards against well-intentioned but dangerous home remedies.

Manual Switching • Simple mechanism is designed for long life under severe service. Contacts are capable of interrupting shorts.

More Wiring Space • Compact mechanism permits wide gutter space in SMALL enclosure.

Full Line • Five frame sizes, many ratings and four enclosure types.

	AMPERE RANGE			
VOLTS	ML	ML 1	ML 2	ML 3	WL
250	15-50	70-100	—	125-225	225-600
600	—	15-50	70-100	125-225	225-600

An Enclosure for EVERY APPLICATION

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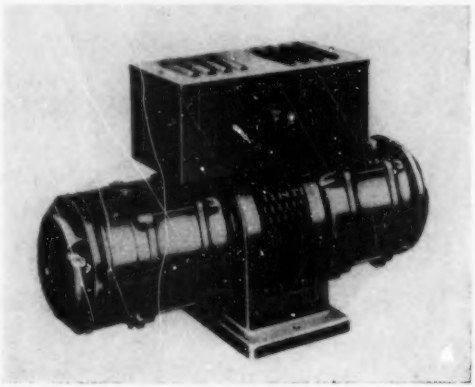
Adjustable Speed Motor System For Polyphase Circuits

The adjustable-speed motor system is fundamentally a system of speed control for operation from polyphase or single phase alternating current circuits.

The system consists of three units: a motor-generator set, a controller, and a drive motor, any of which may be mounted any distance from the others and in any position. A single controller provides sixteen reverse steps of speed adjustment of 150 rpm each to a total of 2,400 rpm and provides full dynamic braking. Each rotating unit is of a special design made by this manufacturer. A vernier rheostat may be connected in the circuit if finer adjustment is required.

Glass insulation is used where practical, providing a minimum of maintenance. Excitation is by a full-wave rectifier of the Tungar type. Sizes are ¾ hp through 3 hp for operation from polyphase circuits and ¾ hp through 1½ hp for operation from single phase circuits.

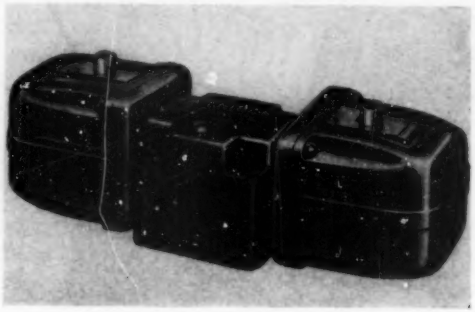


Baldor Electric Co., 4353 Duncan Ave., St. Louis 10, Mo.

Hydraulic Valve Ends Spool-Sticking In High Pressure Lines

To overcome the problem of spool-sticking of 4-way solenoid valves in high pressure hydraulic circuits used for long cycling operations, a pilot operated valve has been designed that utilizes system pressures to move the spool. Solenoids are used only to operate small internal pilot valves. Spool action is said to be smooth, quick and positive under all operative conditions to 5,000 psi.

The valve is available in ¾ in. and 1½ in. sizes, in both single- and double-solenoid types, with provision for either external or internal pilot connections. Eight types of spools provide for eight different porting combinations. In the double solenoid unit, the spool is automatically pressure-centered when the solenoids are de-energized. The valve can be mounted in any position.



The Denison Engineering Co., 1160 Dublin Rd., Columbus 16, Ohio

Unit Traps, Dehydrates and Filters Compressed Air

The model B condensifilter, a device which removes water, oil and other foreign materials from compressed air, is a new development combining in a single unit a dehydrating device, a mechanical filter and a self-purging trap. Measuring only 15 in. high by 9 in. in diameter, it has a capacity of 30 cfm at 100 psi.

The model B condensifilter is recommended by the manufacturers for purifying and dehydrating compressed air used in combustion and process control; in operating pneumatic tools, sand blast and laboratory equipment; in the operation of agitation equipment in food and chemical processing; and in electroplating.

In operation, air is admitted through the side, directed through the condensing section where it is dehydrated, and then passed through the mechanical filter. Total drop in pressure across the condensifilter is less than 2 psi at 100 psi working pressure. The condensing unit, which removes water in both entrained and vapor states, is composed of a series of copper coils through which cold water flows. In passing through this section, air temperature is reduced to within 2 deg of the cooling water temperature; then when the air warms to atmospheric temperature again, a spread between temperature and dew point is effected.

The filtering unit is made of five hexagonal filter chambers in parallel, each chamber wrapped with seven layers of canton flannel. Easily removed for cleaning, it provides over 4 sq ft of filtering area and is said to remove pieces as small as 1.0 to 2.0 microns. Removal of one 1½ in. SAE nut dismantles entire filter for purposes of cleaning and service.

Hankison Corp., 1501 Beaver Ave., Pittsburgh 33, Pa.

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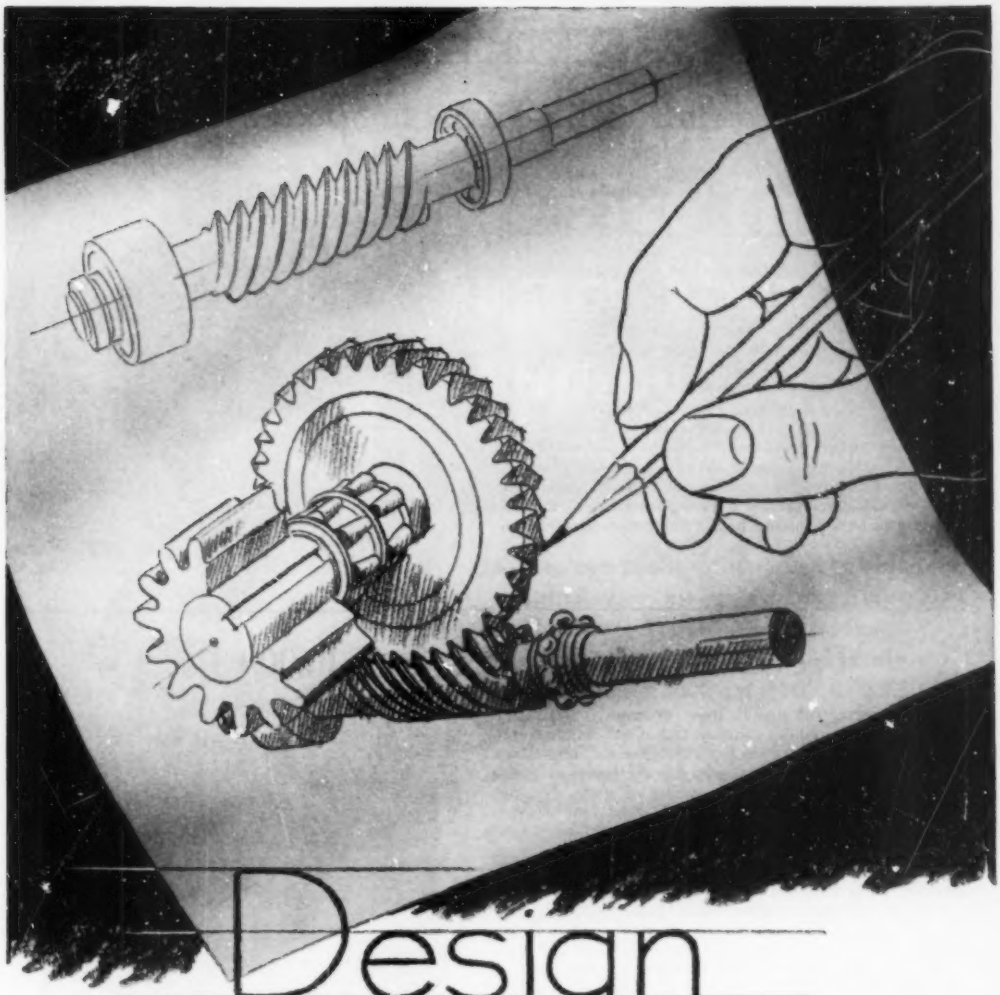
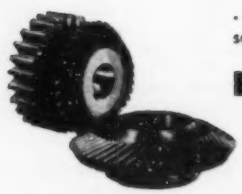


Design

Planning how torque may be applied through gears is a service which, at BRAD FOOTE, we call design. Here . . . in our own plant . . . we have engineers with long experience designing better, more efficient gear assemblies.

- These men well know BRAD FOOTE's creed—*"No one shares our responsibility."*
- They know the gears they design—for use in your shop or on the equipment you sell to others—will bear a proud brand name—BRAD FOOTE. So, our designers start your order on its journey through our plant . . . and through a system of complete control which assures satisfactory performance of the gears you buy.



BRAD FOOTE GEAR WORKS, Inc.

Bishop 2-1070 • OLympic 2-7700 • 1309 South Cicero Avenue
Cicero 50, Illinois

Drive Unit With Variable Speed Sheaves

Designed for installations where driven shaft speeds must be lower than motor shaft speeds, this speed change unit may be used for drives of 2 to 15 hp capacities.

The assembly consists of a sealed ball-bearing counter shaft stand, an adjustable sheave control and a motor adjustment control, all mounted on two rigid sliderods. These components may be removed from the assembly and used separately. The counter shaft stand can be used as a pillow block and located wherever convenient, or the adjustable motor mount may be used in conjunction with a floor mount casting at each end of shortened racks to make up a conventional sliding motor base.

The view at right shows the motor mounted on adjustable slide rails with spring loaded sheave on motor and controllable sheave on countershaft. The control bracket is shown in place and the small multi-groove fixed sheave is mounted to drive the machine at a lower speed over the full ratio provided by the speed selector sheaves. The unit utilizes 7 in. and 8 in. combination sheaves.

Speed Selector Inc., 118 Noble Ct., Cleveland 13, Ohio

Pressuregraph Has Range of 10,000 Psi

This pressuregraph may be used for research and maintenance in jet engines, gasoline and diesel engines, explosion of gases in pipelines, super chargers, air compressors and injection pumps. It provides for the linear measurement and records pressure-time studies of static, dynamic and transient pressures in air, gases, water, and viscous liquids. The pressuregraph has a range from 0.5 to 10,000 psi; a frequency response from 0 to 20,000 cps; and can measure 200,000 separate pressure measurements per second. A linear outline is viewed directly.

The pressuregraph consists of (1) an electronic pick up connected to the pressure area to be studied, (2) an associated electronic circuit and power supply, and (3) a DuMont type 304-H or 208-B cathode ray oscilloscope. Its operation is based on a system of carrier modulation, with the carrier voltage made to vary according to pressure applied to the diaphragm.

Temperature of the pick-up shell must be held below 250 F. Where engine head temperatures run above 250 F; the pick-up must be cooled. Mounting bases are available for either water or compressed air cooling.

The power supply is built in with regulated d-c anode and bias voltages. It operates at 60 watts at 115 or 230 v, single phase 50/60 cycle.

Electro Products Lab., 4501 N. Ravenswood Ave., Chicago 40, Ill.

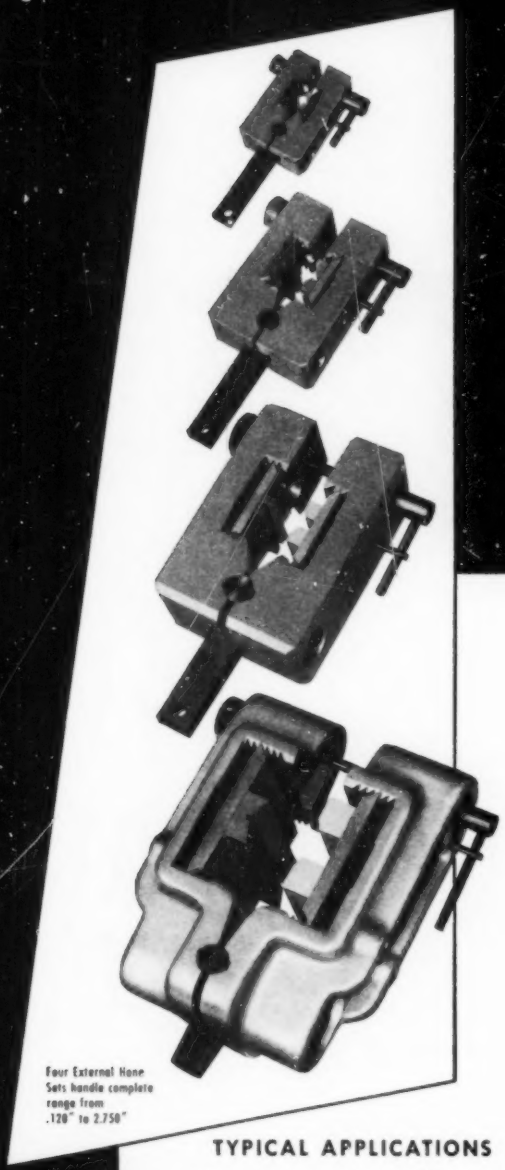
A PACKLESS, LEAKPROOF DECKSTAND has been developed for use with steam, water, oil, gas and chemicals. The inserts providing the seal are lapped together. The movement of the stem in operation has no effect on the seal or wear of the stem. The inserts are of oilite bronze to provide lubrication. Height of deckstand can be made to suit application. Phillips Rotary Joint Valve Co., 5711 Boulevard East, West New York, N. J.

A NUMBER of various size impregnated porous bronze bearings are available in shapes of cylindrical bearings, flange bearings, thrust bearings, cored bar, solid bar and plate stock. Interchangeable with solid bronze bearings. Boston Gear Wks., 71 Hayward St., Quincy 71, Mass.

CONTINUED ON PAGE 234

SUNNEN EXTERNAL HONES Are Five Times Faster Than Lapping

—Says Detroit Manufacturer



Four External Hone Sets handle complete range from .120" to 2.750"

For Pins . . . Shafts . . . Arbors . . . Plungers . . . Spindles . . . Ejector Pins . . . Guide Pins . . . Plug Gages . . . Metering Rods . . . Valve Needles . . . Spools . . . and other external diameters from .120" to 2.750".

These hones are guaranteed accurate to within .0001"—25 millionths can be held in some applications, with stock removal controlled all the way. Surface finish of 2 micro-inches RMS can be obtained in hardened steel. Sunnen External Hones are ideal for removing centerless grind patterns, for correcting barrel, taper, out-of-round, waviness, and heat treat warpage.

If close tolerances on O.D.'s are a problem in your plant, you should know what Sunnen External Hones can do for you. Send for Free descriptive booklet.

637

TYPICAL APPLICATIONS

Valve spool | Needle valve | Gage bar | Ram

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Canadian Factory: Chatham, Ontario

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7976 Manchester Ave., St. Louis 17, Mo.

☐ Please send bulletin on external honing. ☐ Have representative call.

Name.....

Company.....

Address.....

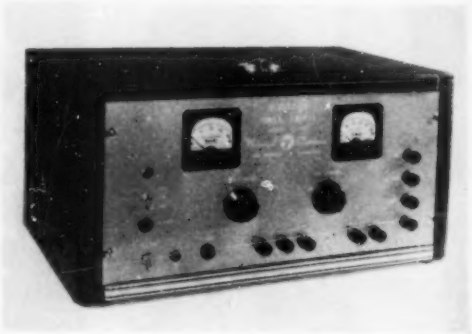
City.....Zone.....State.....

Compact Regulated Power Supply Unit

The new, regulated power supply furnishes from 0 to 200 ma at voltage continuously variable from 0-325 v, d-c without switching. Bias voltage supplied can be varied from 0-150 v with 2 ma max. Also furnished from the unit are two independent outputs of low a-c voltage that may be used separately or combined to furnish either 12.6 v at 3 amp or 6.3 v at 6 amp. Under the supply's strict regulation, the high voltage varies less than 0.2 v from no load to full load, 0-325 v, or for line voltage fluctuations from 105 to 125 volts. Hum voltage is within 2 millivolts rms for any voltage or load within ratings. Internal impedance is less than 1 ohm d-c and less than 0.2 ohm from 20 cycles to 50 kilocycles.

Either positive or negative high voltage output terminals may be grounded, and the positive terminal of the bias supply is permanently connected to negative high voltage terminal. For protection the line and plate supply are separately fused, and fuses are accessible from the front panel.

The supply is offered in a birchwood cabinet, steel cabinet in black or grey wrinkle finish, or for rack and panel mounting. The front panel is made of aluminum alloy with silver hammertone finish. Dimensions: cabinet, 21 in. wide, 10½ in. high, 15 in. deep, excluding control knobs. The front panel is 19 in. wide by 8¾ in. high.



Universal Electronics Co., 2012 S. Sepulveda Blvd., Los Angeles 25, Calif.

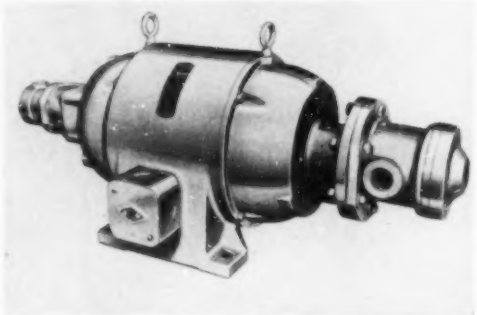
Direct Mounting of Hydraulic Pump Motor

A new hydraulic pump motor, which features a new system of direct mounting between pump and motor, has been standardized and is adaptable to all makes of pumps.

The main feature of this new development is the automatic precision alignment in every installation. All motors are supplied with machined endbell flanges, pre-engineered to fit the registers on the pump mounting flange.

The elimination of the alignment problems, reduces both original cost as well as maintenance. This is particularly so in high pressure pumps where tolerances between the impeller and housing are normally held very close, and even the slightest misalignment causes excessive wear. Installation costs are reduced also by merely bolting the two flanges together, rather than mounting each unit separately and aligning. The fabrication of special mounting platforms for raising the impeller shaft to drive shaft height is also eliminated. Overall dimensions are reduced.

Hydraulic pump motors can be supplied with pump flange mount on one or both endbells in all standard ratings of hp and speed. Several combinations of different sized pumps per motor are available in all types except totally enclosed fan cooled and explosion proof. These are available in single pump mounts only. All motors are in accordance with standard NEMA dimensions.



Reuland Electric Co., Alhambra, Calif.

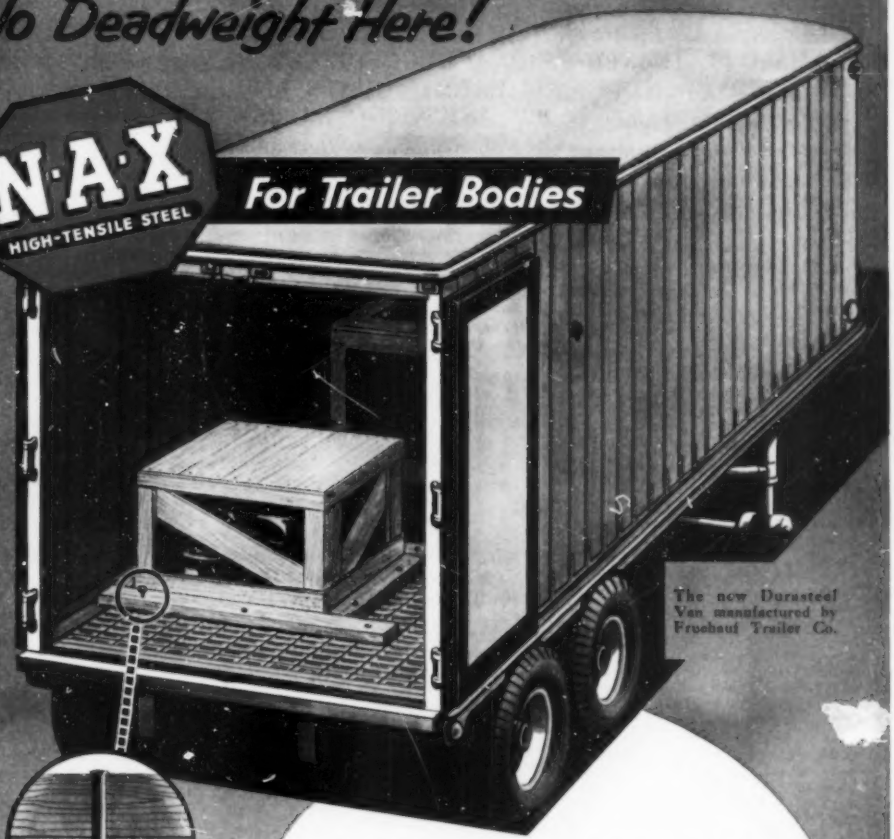
A NEW ARMORED ATTACHMENT CAP has as its feature a metal cord clamp. Although equally strong as similar devices, the advantage of lighter weight is claimed for this product. The compression molding process used assures a minimum breakage. Suitable for universal usage, the cap has two parallel blades that fit any standard outlet. It is also available with double-action spring blades that provide the tension grip required for special purposes. Catalogued as no. 1120, the cap is rated 10 amp, 250 v and 15 amp, 125 v; cord hole diameter is 0.500 and O.D. is 1½ in. It has brass blades and screws, and the cord clamp and armor are coated to resist rust and corrosion. More information may be obtained from the manufacturer. Rodale Mfg. Co., Inc., Emmaus, Pa.

CONTINUED ON PAGE 236

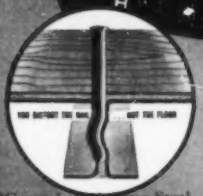
No Deadweight Here!

N·A·X
HIGH-TENSILE STEEL

For Trailer Bodies



The new Duraisteel Van manufactured by Fruehauf Trailer Co.



*Great Lakes Strap-Steel Flooring has high strength and light weight. Its unique nailability permits safe blocking of loads. You distort the nail... not the floor.

America's first all-steel trailer body is on the highways—roof, sides, framing and flooring, all of N-A-X HIGH-TENSILE steel. Years of planning, testing and research went into this unique trailer body, making it the most serviceable ever built.

1. The use of N-A-X HIGH-TENSILE steel in this equipment results in light weight with strength and durability.
2. In addition to greater strength, N-A-X HIGH-TENSILE steel has greater resistance to fatigue, impact, corrosion and abrasion. It offers a greater strength-to-weight ratio with longer life and larger payloads.

More and more of America's highway equipment manufacturers are swinging to N-A-X HIGH-TENSILE steel. Millions of on-the-job miles have proved the superior qualities of this steel . . . have proved its over-all economy.

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

SCRAP
STEEL

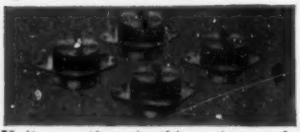
SHOCK and VIBRATION NEWS

BARRYMOUNTS FOR ASSURED CONTROL OF SHOCK AND VIBRATION

SMALL PLATE-TYPE BARRYMOUNTS

for Mounting Light Industrial Equipment

New Series 6300 Barrymounts are designed to fill the need for plate-type vibration isolators requiring little mounting space and carrying light to moderate loads.



Unit mountings in this series can be furnished with load ratings as low as one pound and up to 11 pounds. The free height of the top of the unit mounting, above the central mounting plate, is approximately 23/64 inch. The symmetrical design permits loads to be applied either axially or radially, or with components in both directions.

Designed primarily as vibration isolators, the Series 6300 units have a transmissibility of about 6 at resonance, which occurs at approximately 15 cycles per second under rated load. Vibration isolation at 30 cycles or above is extremely efficient. The stability of the mounting is excellent, and transient shock isolation is satisfactory for the intended service.

These new Barrymounts are available in two mounting styles: Series 6300, with two holes on 1-13/32 inch centers, and Series 6780, with four holes at the corners of a one-inch square. Detailed ratings, performance data, and dimensions are given on Data Sheet 608. Write for your free copy today!

FREE CATALOGS

- 502 – Air-damped Barrymounts for aircraft service; also mounting bases and instrument mountings.
- 509 — ALL-METL Barrymounts and mounting bases for unusual airborne applications.
- 504 — Shock mounts and vibration isolators for marine, mobile, and industrial uses.
- 607 — How to cut maintenance costs by using Barrymounts with punch presses.
- 605-606 — Miniaturized air-damped Barrymounts for use with airborne equipment.

"RUGGEDIZED" BARRYMOUNTS AND MOUNTING BASES

Now Available to Meet Shock Requirements of AN-E-19

Barry vibration isolators and mounting bases are now available in "ruggedized" construction, to withstand the severe shocks of arrested landings in aircraft carrier service and of crash landings. These units are tested to meet the shock-test requirements of Specification AN-E-19, for the equipment sizes listed in JAN-C-172A.

"Ruggedized" Barrymounts are available in both the air-damped type and the ALL-METL type. Air-damped Type 770R covers load ranges between ¼ lb. and 9 lbs. Air-damped Type 780R covers load ranges between 4 lbs. and 35 lbs. ALL-METL Type 6600R covers load ranges between 4 lbs. and 35 lbs. Type M-112R covers ranges between 2 and 10 lbs.

"Ruggedized" mounting bases, equipped with Barrymounts of the above types, are available in standard JAN sizes (JAN-C-172A) and in special sizes to meet customers' requirements. A conspicuous advantage of these "ruggedized" Barry bases is the gain in strength of the base framework itself — beyond JAN requirements — achieved with very little increase in weight for loads up to 60 lbs. by design modification of standard JAN bases. For greater loads, the "ruggedized" Barry bases are of stainless steel instead of aluminum. Write for data sheet.

THE BARRY CORP.

730 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

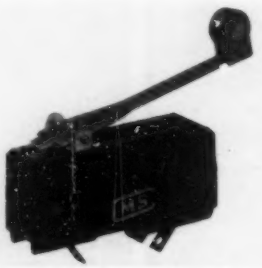
SALES REPRESENTATIVES IN

New York Rochester Philadelphia Washington Cleveland Dayton Detroit
Chicago Minneapolis St. Louis Seattle Los Angeles Dallas Toronto

Lever Actuated Micro Switch Easily Operated

Rigid lever actuated high capacity basic micro switches, requiring a lower operating force than that of the flexible leaf actuated switches, are now available in the following classifications: ¾ hp, 115 v, a-c; 1½ hp, 230 v, a-c; 20 amp, 125, 250, or 460 v, a-c; 10 amp, 125 v, a-c "L" ("L" suitable for controlling tungsten filament lamp loads on a-c circuits).

In this serious of switches there



is a choice of a long straight lever, a short lever with a roller, and a long lever with a roller. The switches have a 0.020 in. contact break distance with a single-pole, double-throw contact arrangement. The three types of terminals available are: (1) solder lugs, (2) integral screw terminals, and (3) side facing binder head screw terminals.

Micro Switch, Freeport, Ill.

Low Speed Motor Has Low Voltage Control Circuit

A newly designed low speed torque device of the shaded pole type has as its outstanding feature a built-in low voltage control circuit which starts, stops, and reverses. Other features are: not burning out under continuous stall, and lifetime lubrication under normal conditions.

The case totally encloses the built-in gear train, rotor, stator, and a low voltage control circuit is provided. An adaptor assembly can be supplied for line voltage conduit installations. The standard, tool steel, output shaft extension is ½ in. and can be provided in other lengths. Shaft speeds are standard at 2, 7½ or 27 rpm, with torque characteristics to 10.0 in-lb. Internal stopping pins are available to limit motion from 90 to 270 deg or unlimited rotation in either direction

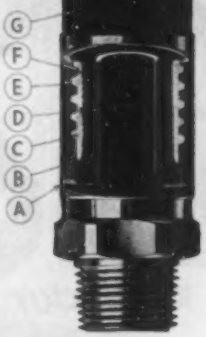
Stop High-Pressure Leaks and Blow-offs

—with ANCHOR Ductile Sleeve Hose Couplings

Factory application of Anchor's exclusive Ductile Sleeve Coupling is your best insurance against leaks or blow-offs. Our superior grip gives you a plus margin of safety and a minimum time loss due to lay-up of equipment.

Here's how it works (referring to the illustration): Cover stock (G) is removed from the hose by grinding and buffing. Ductile Sleeve (C) is slipped on the end of the hose over the bare wire. Coupling body (A) with steel insert (B) attached is placed in position on the hose. The coupling is then swaged radially on the hose, imbedding the ductile sleeve into the internal grooves of the coupling shell (E) and into the mesh of the wire braid reinforcement (F). This is the exclusive Anchor patented grip.

Some of the applications of Anchor high-pressure flexible oil lines include high-pressure riveting, road machinery, snow plows, coal mining machinery, material handling machinery, machine tool applications, agriculture, railroads, oil field machinery, liquefied petroleum gas, lubrication and various other installations.



Clamp-type Couplings

2-Piece Re-usable Couplings

NPTF Straight Adapter Unions

45°-90° Adapter Unions

Other styles of related fittings available for piping installations

ANCHOR COUPLING CO. INC.

Factory: Libertyville, Illinois • Branch: Detroit, Michigan

Send for complete information on Anchor assembled hose units.

Clip coupon to company letter head —and mail TODAY!

ANCHOR COUPLING CO. INC. Dept. PE101
Libertyville, Illinois

I want engineered-information on cost-cutting Anchor Ductile Sleeve Hose Couplings. Please send me Bulletin No. 48.

Name..... Position.....

Company.....

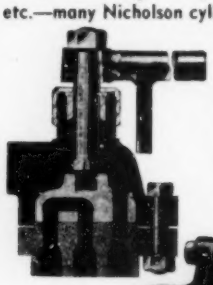
Company Address.....

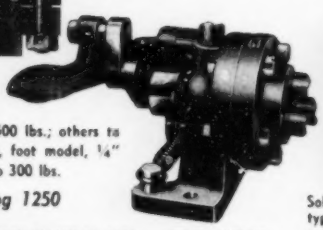
City..... (.....) State.....

NICHOLSON CONTROL VALVES SET

RECORDS FOR LONG LIFE

In a wide range of plants—steel, metal working, processing, etc.—many Nicholson cylinder control valves have now been in continuous service for over 25 years. Their capacity for long leak-free service is confirmed by repeated installation records showing Nicholson valves actually become tighter with use. This is because their non-corrosive flat discs tend to lap themselves on the seats. For air, gas, oil, steam, water.





Above, lever model, ¼" to 2½", press. to 500 lbs.; others to 5000 lbs. Right, foot model, ¼" to 1½", press. to 300 lbs.

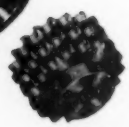
Solenoid and motor types, ⅛" to 2½"; press. to 375 lbs. Many metal combinations.

Catalog 1250

W. H. NICHOLSON & CO. 200 ORFGON ST. WILKES-BARRE, PA.

Sales and Engineering Offices in 53 Principal Cities

SPROCKETS are easy to order...



...RIGHT OUT OF THE CATALOG

When the job calls for stock roller chain sprockets —Sewall is as near as your telephone or mailbox. Precision-made Sewall sprockets add life to your chain drives—and they're available in a wide range of sizes. Do you have our catalog?

Prompt quotations on all types of custom built sprockets—engineered to your specifications.

By the Makers of Sewall Gears

NEster 1381

E. B. SEWALL MANUFACTURING CO.

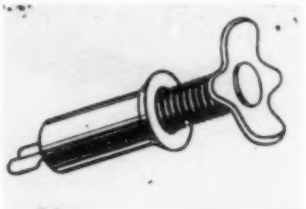
696 Glendale St. • St. Paul 4, Minnesota

if desirable. The Crise model AD is enclosed in an aluminum die cast housing measuring 5 in. high, $3\frac{1}{16}$ in. wide by $1\frac{3}{4}$ in. deep.

Acro Mfg. Co., Columbus, Ohio

Double-Action Sheet Clamp

A new type of sheet clamp is available for use on thin straight sections, as well as heavier, curved, bent, or poorly aligned sections. This clamp, called the Interlock sheet clamp has a



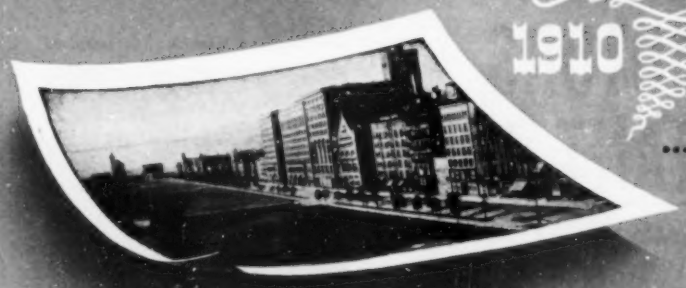
spring that can be compressed by hand, and a screw action that provides extra pressure when needed. Not requiring pliers for installation, the interlock saves manhours.

Sizes available are $\frac{5}{32}$ in., $\frac{1}{8}$ in., $\frac{5}{32}$ in., $\frac{1}{4}$ in. The clamping rod overhang is half the dia of the rivet hole.

Air Associates, Teterboro, N. J.

Rectifiers for Airborne Applications

A new type of rectifier has been assembled in half-wave cartridges with current ratings from 300 microamps up to 60 milliamps. The individual cartridges accommodate up to 400 cell elements with d-c voltage ratings up to 8,000 v per cartridge, and by connecting a number of cartridges in series, voltages up to 250,000 v have been obtained. The assembly is rugged and impervious to the effects of outside atmosphere, and with units



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Impressive! Significant! Chicago's growth through 41 years. Impressive, too, the 41 years of Stewart progress . . . in working techniques . . . engineering skill . . . and *above all* EXPERIENCE! When next you face a casting problem, consider the long years of direct contact in application and end use requirements of Stewart craftsmen. You'll find them *always* an assurance of dependable service.

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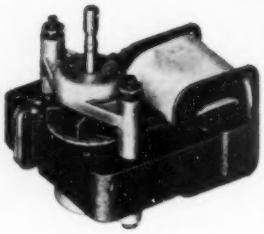
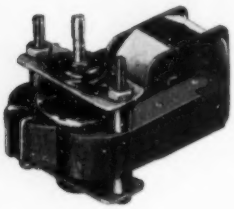
We take pride in being known by the customers we keep

SMALL MOTORS FOR IMPORTANT JOBS

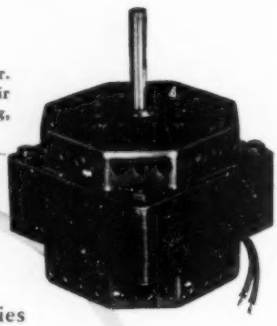


MODEL A . . . 1/125 to 1/200 H. P.
2-pole, shaded pole induction motor. Features include novel bearing construction which insures rigid and permanent alignment of motor shaft...oilless bearings.



MODEL C . . . 1/250 to 1/500 H. P.
2-pole, shaded pole induction motor. Features include accurately aligned motor shaft . . . oilless bearings.

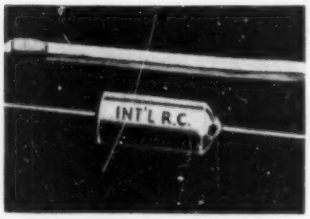
MODEL D . . . 1/50 to 1/100 H. P.
4-pole, shaded pole induction motor. Features include scientifically designed air intake . . . dual cooling fans . . . self-aligning, oilless sleeve bearings.



These General Industries *Smooth Power* motors are ideally suited for all types of applications requiring low-torque drives.

Write for complete information!

THE GENERAL INDUSTRIES CO.
DEPARTMENT D • ELYRIA, OHIO



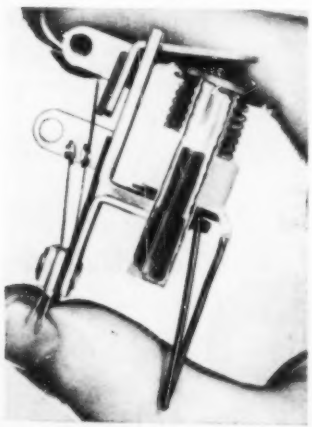
capable of withstanding 100 G's of acceleration, they are suited for airborne applications. They can be operated in ambient temperatures up to 100 C. The outside diameters vary from $\frac{3}{16}$ in. up to $1\frac{1}{4}$ in. depending upon current rating. These rectifiers are designed for applications such as airborne radar components, guided missiles, bias supplies, inverse peak clippers, oscilloscope power supplies, solenoid power supplies, and modulators.

International Rectifier Corp., 6809 S. Victoria Ave., Los Angeles 43, Calif.

Small Time Delay Relay

A new type of time delay relay has been announced which utilizes a hydraulic magnetic operating principle, and has only one moving part in the time element. This moving element is hermetically sealed and never needs attention.

Known as the Silic-O-Netic time delay relay, it has a sealed tube which extends through and below the relay coil. The tube, in turn, is filled with a viscosity-stable silicone liquid, and holds a movable iron core. When the coil is energized, the movable core is drawn up into the magnetic field but the rate of rise is controlled by the silicone liquid, introducing an exact time delay. The relay operates on the



Customer Reports:

ONLY 250 LBS. REJECTED OUT OF 2,000,000 WITH ASARCO CONTINUOUS CAST BRONZES!

A prominent manufacturer of railroad equipment reports: Only 250 lbs. of Asarco Continuous Cast bronze rejected out of a 2,000,000 lb. experience . . . better properties than other bronzes . . . scrap losses practically eliminated.

There are virtually no rejects when you use Continuous Cast bronzes. The unique Asarco casting process gives you bronze rods, tubes and shapes with fatigue and impact characteristics up to 100% better than those of sand cast bronzes . . . with better tensile strengths, yield strengths and hardnesses . . . with no porosity, no hard or soft spots. Asarco Continuous Cast bronzes are ideal for use on automatic screw machines.

You can get Continuous Cast bronzes made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ on special arrangement.

216 sizes of the standard Asarcon 773 bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in principal cities across the country. Distributors will cut the warehouse stock to suit your specific requirement . . . *long or short.*

For more data see your Asarco distributor, or send the coupon for a 12-page color catalog that contains complete technical data.

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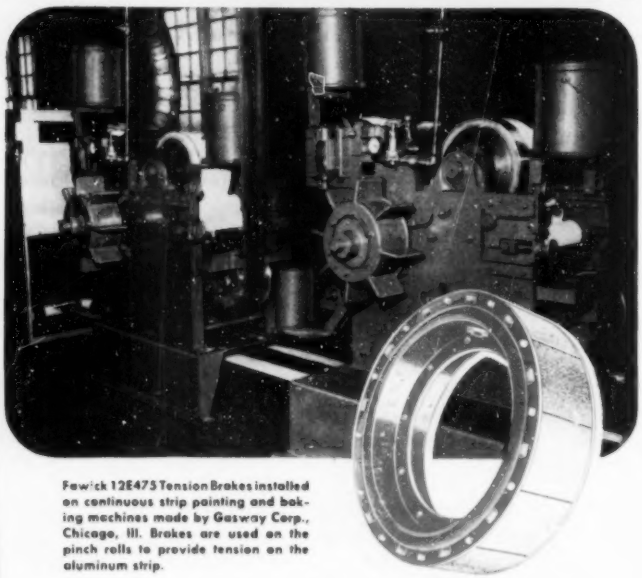
for TOP CLUTCH AND BRAKE PERFORMANCE SPECIFY FAWICK FOR YOUR MACHINES



Fawick 12E47S Tension Brakes installed on continuous strip painting and baking machines made by Gasway Corp., Chicago, Ill. Brakes are used on the pinch rolls to provide tension on the aluminum strip.

Manufacturers of many different types of industrial machines insure top clutch and brake performance on their equipment by using Fawick Airflex Clutches and Brakes.

As to design, the compact structure of Fawick units contributes to the overall design efficiency of the machine, requiring less space for these important components.

From an operating standpoint, Fawick provides performance-proved advantages of split-second, positive control, elimination of clutch lubrication, and self-adjustment to compensate for wear. These characteristics, plus long, trouble-free operating life under all operating conditions, make FAWICK AIRFLEX CLUTCHES AND BRAKES the natural specification for top performance of your machines.

FAWICK AIRFLEX COMPANY, INC.
9919 CLINTON ROAD • CLEVELAND 11, OHIO

For specific information on all advantages of Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, O., for Bulletin 300.

FAWICK Airflex
INDUSTRIAL CLUTCHES AND BRAKES

increased magnetic flux caused as the core reaches the pole piece at the top of the tube.

These relays are available with timings up to 4 minutes and there is no appreciable effect on the relay time caused by ambient temperature or position changes normally encountered. It has a rated capacity of 10 amps at 120 v a-c. Overall dimensions are $1\frac{5}{8}$ in. by $2\frac{1}{2}$ in. by $\frac{3}{4}$ inches.

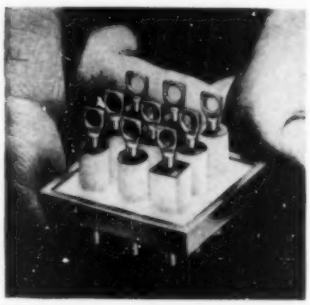
Heinemann Electric Co., 308 Plum St., Trenton 2, N. J.

Hermetically Sealed Transformer Terminals

One to nine pin transformer terminals are available in the hermetically sealed AF, AG, AH, and AJ size transformer cases in specification MIL T-27.

The fluorocarbon-metal hermetic seal structure is micro-crystalline in nature and the seal gradually changes from a pure fluorocarbon resin to a pure metal.

The fluorocarbon-metal hermetic seal is called Teflon, and will withstand



severe mechanical shock and vibration, and thermal shock. There is no strain point as with fused glass or ceramic metal seal. The terminals are serviceable at temperatures from —150 F to 525 F without change in electrical characteristics. Having zero water absorption, they are not affected by extreme humidity. In addition, Teflon is impervious to corrosive atmosphere and fungus, and is non-flammable.

U. S. Gasket Co., Camden, N. J.

New Capacity Size Magnetic Starter

Rated at 10 hp, 220-550 v, 3 phase, a-c, this is neither a No. 1 nor No. 2 starter in the regularly designated size pattern, but an in-between size. Heretofore, when a 10 hp starter was re-

Enthusiastic Users Praise Its Great New Lubrication Savings!

From 3 gallons per day to 4 ounces per day!
A leading pump manufacturer* announces this saving after installing Oil-Mist on a single machine.

ALEMITE OIL-MIST AUTOMATIC LUBRICATION SYSTEM

From 3½ gallons to 6 ounces per 24 hours!
This is the oil reduction on two multidrilling machines reported by a nationally famous motor car manufacturer*

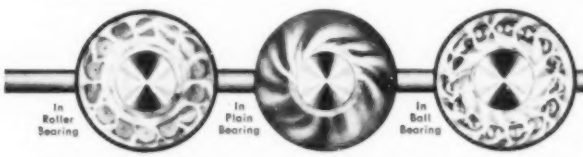
From 1 gallon per day to 2½ ounces per day!
The amazing decrease in oil consumption of a well-known metalworking company*

From 100 ounces in 8 hours to 5 ounces in 8 hours!
So reports a prominent tire and rubber company* after installing Oil-Mist on a single sole trimmer.

The Most Sensational Time, Money and Labor Saving Development in Lubrication History

Fully automatic, unbelievably simple . . . Alemite's revolutionary Oil-Mist Lubrication System *atomizes* oil into mist, distributes it through tubing to bearings. Bathes *all* bearing surfaces with fresh, clean, cool oil film. Uniformly maintains oil film on all sliding, rubbing, rolling parts regardless of variations in load, temperature or speed. No "peaks and valleys" of lubrication.

Proved in use by all segments of U. S. Industry—automotive, aircraft, printing, packaging, canning, appliance manufacturers, metal processors and fabricators, food processors of every sort—Alemite Oil-Mist assures new savings, big savings . . . *savings never possible before* in machinery lubrication! Get the proof yourself through a Desk-Top Demonstration. Clip and mail coupon below *today!* *Name on request



No Other Lubrication System Made Provides All This!

- Continuous lubrication—to all bearings simultaneously.
- Automatic control, permitting each individual machine to receive proper lubrication whenever in use.
- Elimination of guesswork. The bearing picks up only as much oil mist as it needs.
- Reduced Oil Consumption—Up to 90% in some cases.
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Warm and pleasant to the touch, it will *not* splinter, warp, or shatter. It has no dangerous, sharp edges. It is highly resistant to impact. Its colors are everlasting. And it can be formed on standard equipment with conventional techniques.

ROYALITE PONY TRICYCLE FIXTURES — This exciting, new, drawformed Royalite pony head and saddle add new glamour to children's tricycles. Developed in Royalite and fabricated by Regal Plastic Co., Kansas City, Mo., for Texas Bronc Mfg. Co.

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ROYALITE IN THE FURNITURE INDUSTRY — U. S. Royalite gives designers and engineers greater freedom of design than conventional materials — allows them to use flowing sweeps and curves.

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The United States Rubber Company at 2638 North Pulaski Road, Chicago, Illinois, has complete Engineering, Designing, and Styling Departments to assist fabricators on the technique to employ, and in the art of fabricating most efficiently with ROYALITE.

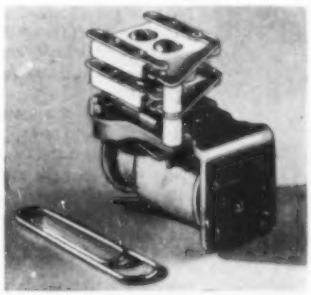
quired, it has been necessary to get the No. 2 size rated up to 25 hp.

This series (YE) has renewable, rectangular type contacts of specially developed silver for maximum arc-quenching properties and low contact resistance. The terminal boards are of arc-resistant alkyd and equipped with pressure connectors. Measurements are 6¼ x 10¾ x 4¼ inches.

Furnas Electric Co., 1050 McKee St., Batavia, Ill.

Midget Relay Has Low Capacitance

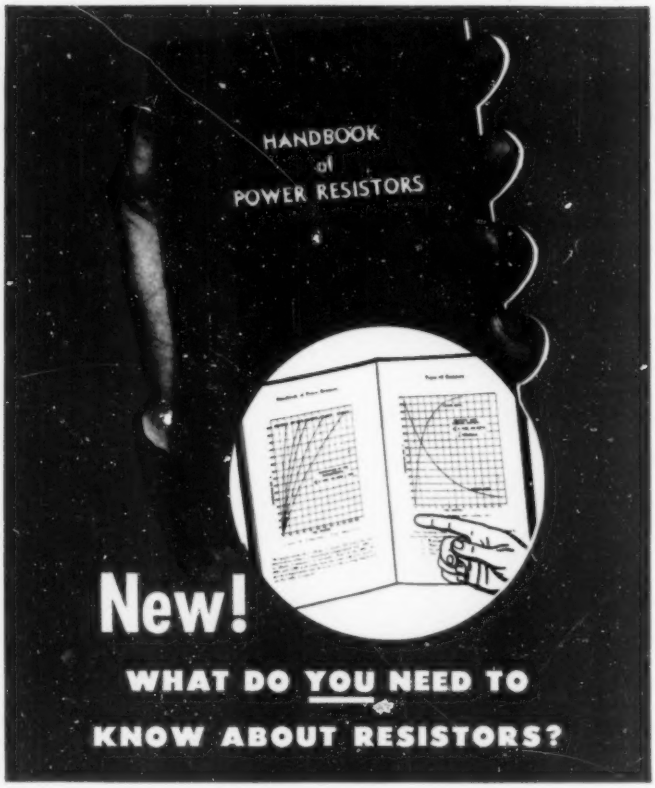
This midget relay is reported to have a maximum capacitance between contacts and to ground of 2½ micro-microfarads. It can be furnished with single pole normally open or normally closed, two pole normally open or normally closed, and single pole double throw contact. It is also available up to 4 pole double throw in standard contact arrangement. Maxi-



mum is three amp non-inductive at 28 v d-c.

This relay is suited for small dynomotor service when furnished with a special single pole parallel break contact construction.

R-B-M Div., Essex Wire Corp., Logansport, Ind.



This new Ward Leonard handbook illuminates a hitherto neglected subject

Somehow—resistors, particularly power resistors, have never been given adequate attention in electrical industry literature.

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This handbook is modestly priced at $3.00. Order from WARD LEONARD ELECTRIC CO., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

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Sans, Souci

Ad Libbing By the Editor

When I was in college I had a number of profs who stood out considerably above the others, as is invariably the situation. One of these was "Hunt" Wily, who was professor of physics and later became the owner and operator of a highly successful manufacturing company. I will never forget the first two freshmen lab sessions I had under Hunt Wily.

At our first lab session, Professor Wily went to great pains to explain exactly how we were to make our laboratory reports. He stressed the fact that he wanted schematic drawings and emphasized the schematic feature at some length. Being an enthusiastic ambitious freshman I immediately decided that I was going to give the prof a far better report than he had asked for. So far into the night I labored making beautiful pictorial sketches of the laboratory set-up used in the test. I was very proud of these pictures: They even showed the graining of the wood, highlights and shadows and the slots in the screw heads.

I handed in my report at the next lab session. Professor Wily called me into his office. He sternly asked me if I had been at the first laboratory session. He knew that I had been there because he kept the roll book. Of course I told him I was there. He then asked me if I remembered what instructions he had given with reference to schematic drawings. I said I did. With that, Hunt took my laboratory report, tore it into four pieces, flung it across the desk at me and said. "Do it over again and do it the way you were told." I got so mad I couldn't see straight.

It was not until I had a bull session with my senior roommate and had wept on the shoulders of anybody who would listen to me that I woke up to the fact that Hunt Wily was using drastic tactics to teach me a very important lesson. He succeeded, perhaps even beyond his then fondest expectations. But years later when Hunt was running the Conestoga Corporation in Bethlehem, Pa. I had lunch with him and recalled the incident. He laughed merrily and made the remark, "George, if I had not learned the lesson that good enough is perfect, I would never have been a success as a manufacturer or in any other business. Any commercial undertaking in which the product possesses costly and superior qualities for which the prospects are not

willing to pay always proves to be unprofitable."

Then I told Hunt about my own experience as a college prof. I also had a student in the laboratory who insisted on making fancy reports. I wasn't quite as tough as Hunt was. However, I called this student into my office and showed him his laboratory report and another report which was equally well written but it did not contain the fancy colored ink graphs and sketches. I told the student that although he had spent many hours more on his report his mark was no better than that given to the man who had the equally good report but without the fancy illustrations. He was very much chagrined but soon saw the point. He was spending many hours producing something which had no market value.

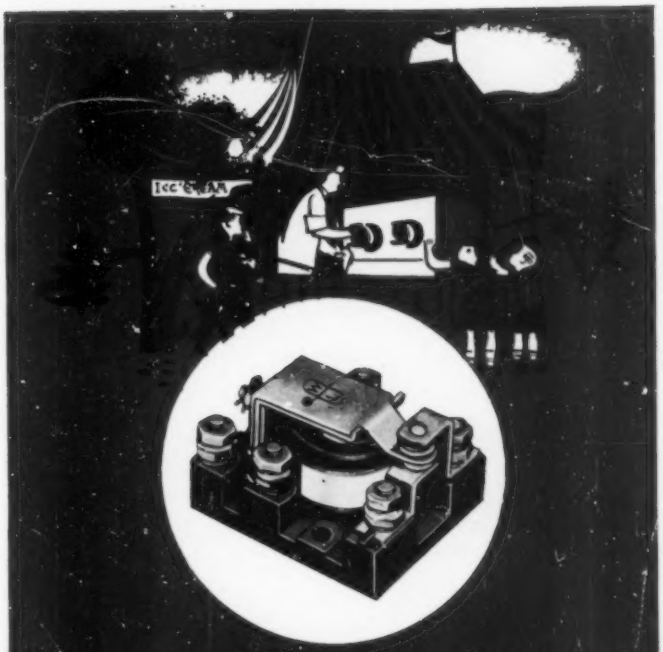
If we were to plot a graph with time spent on a job as the abscissas and percent perfection as the ordinates we would find that the graph would go up relatively steeply in the beginning but would then flatten out and become practically parallel to the X-axis. In other words, we sooner or later arrive at a point where many additional hours of further effort shows only an unappreciable or even an invisible increase in quality or efficiency. The smart producer is the man who knows when to stop and thereby is able to deliver the maximum amount of acceptable production in minimum time and cost. Only too often hours and hours are spent in an attempt to further improve a design. But the slight improvement achieved is not worth the effort.

Poor Lena

All this reminds me of the story of the unfortunate man whose wife was in the hospital. Sometime later one of his friends asked him how his wife was getting along. The poor man replied in a sad tone, "Ach, my Lena is dead." His friend expressed his sympathy and asked Heinie the cause of his wife's death.

Heinie replied, "Every morning when I called at the hospital I asked them how my Lena was and they told me she was improving. And then one morning when I asked them how my Lena was they said she was dead. So I guess she died of improvements."

That is the way it goes with too many attempts to improve an existing design. It seems that the project is launched and after a great deal of time and money has been spent, the engineers feel that they must come up with some kind of an "improvement". Of course, it will be a change from the previous design, but may be no im-



LITTLE RELAY OUSTS BIG STARTER

and saves customer both space and money

An ice cream freezer manufacturer* was perfectly content with the across-the-line starters used in his equipment.

But we got the idea of saving him some room and dollars by substituting Ward Leonard heavy-duty midget *relays.*

It's a really rugged relay, and certain types are Underwriters' listed as motor controllers. Months of testing proved that a standard Ward Leonard relay with just slight changes would do the job of the heavier starter.

It's another case of Ward Leonard "Result-Engineering" Write us for Bulletin 105 on the heavy-duty midget relay, or for *any* control problem, write WARD LEONARD ELECTRIC CO. 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

*Sweden Freezer Manufacturing Company, Seattle, Washington.

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WITH BI-SEAL SELF-BONDING POLYETHELENE BASE TAPE

Forms into a solid mass of insulation and produces moisture tight seals by means of a gasketing action on all materials.

CHECK THESE EXCLUSIVE FEATURES:

- Fuses into a non-laminar homogeneous mass.
- Excellent dielectric characteristics.
- A perfect moisture barrier and corona resistant. (Can be applied at —30° F). Prolonged ageing without deterioration.
- Will not corrode metals.
- Easy to apply—conforms readily to odd contours.
- S. I. C. 212. P. F. .0004 @ 10 m.c.

A FEW OF THE MANY BI-SEAL APPLICATIONS:

- Torroids — Coils — Resistors — Deflection Yokes —Antennas
- Electroplating. Masking surfaces of external recessed diameters. Clean edges eliminate the need of lacquers.
- End Sealing for Cables.
- Electrical Insulation—High Frequency—High Tension.
- BI-SEAL is suggested as an underwater sealing mechanism both for dielectric and hermetic sealing.

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Please send BI-SEAL Data.

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Address .....

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provement whatsoever or even a very distinctly poorer design.

Destruction Is Not Progress

Bruce Dieterich was not only a man of considerable abilities but he was highly respected and loved by his associates. Then there came a time when there were promotions in the company and Bruce was passed by. Most of his friends felt that he should have been promoted. One of them went to Bruce and not only said so but also severely criticised the promotion that had been made.

Bruce looked at his friend and smiled and said, "You have the wrong idea. Tearing down the fellow who was pushed ahead of me does not do any good. It could do a lot of harm. One should always look for his advancement not through criticising others but by making himself more valuable to the company and more effective as an employee.

"If for some reason or another the company decides to promote the other fellow, that is that fellow's good luck. He is then in that position, not you. And you cannot possibly serve the interests of your company or yourself by undermining the other man's position through criticism. In fact, the only thing you will succeed in doing is to make yourself so dissatisfied that it will be reflected in your work and finally will make you worthless as an employee."

Over the years I have seen exactly that situation develop in a number of instances. Men can become so dissatisfied because they were not the one who was promoted that they are finally completely out of tune with the whole organization. Whenever a man gets in such a state of mind the best thing he can do is to hurry up and get another job. In that way he will avoid the onus of having been fired or the onus of doing such poor work that he becomes unpromotable.

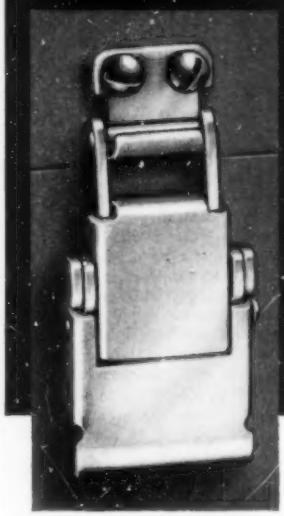
A Job For Engineers

In the current editorial I propose something that may startle many of our readers. I urge that the national engineering societies take active stands particularly with reference to waste, inefficiency and dishonesty in government. I would just like to remind the reader that the greatest contribution towards a more efficient and economical operation of government that is now before the country, is the recommendation of a former president of the American Institute of Mining Engineers, better known as the only living ex president of the United States of America, Herbert Hoover. This fact is simply indicative of the close

New Spring Loaded Catch

with concealed spring

Meets U. S. Signal Corps Specifications



This new Corbin Compression Spring Draw Pull Catch has a concealed spring, flush surface, no protruding parts. 60 pound load at ⅛ inch deflection. Withstands 600 pound pull test. Overall dimensions are 2¾ x 1¼ x ⅜.

For full details on this and other Corbin Draw Pull Catches, write or phone:

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GITS Unit* SEAL
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*Cartridge Seal . . . pressure balanced . . . requiring only 25% more space than lip-type seals.

If *you* have a shaft sealing problem, Gits experience in these and many other specific applications can prove of great and immediate value to you.

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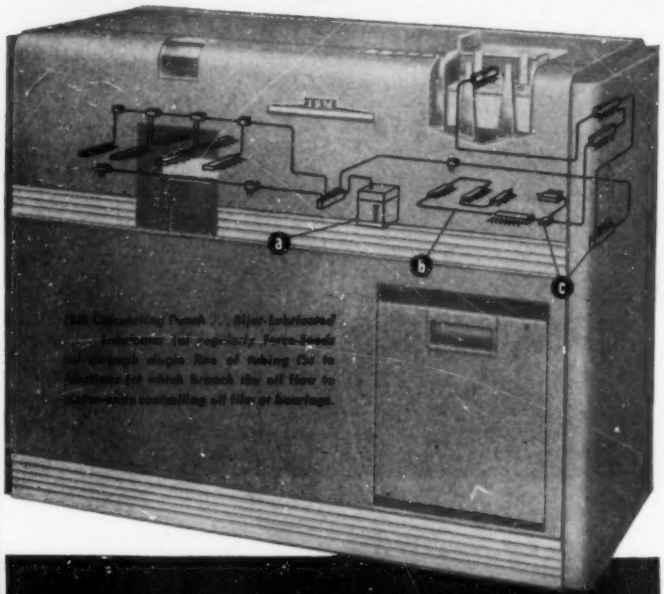

over 100 bearings lubricated...automatically

All 109 bearings of this machine must be oiled at once *during operation* to maintain continuous production. The Bijur system does the job by connecting all bearings to one lubricator, driven by the machine.

No sign of a system is seen outside the machine as it is completely built in at time of manufacture. This makes for a compact internal design and a clean-lined exterior.

All bearings are oiled at once, yet each one receives individual attention from Bijur, the system with positive Meter-Unit control of oil flow *at the bearings.*

For further details write for "The ABC of Modern Lubrication."

388

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LUBRICATING CORPORATION

ROCHELLE PARK, NEW JERSEY

tie between engineering and efficient government operation.

As pointed out in the editorial, many of the activities of government are related to or created by engineering. As so ably demonstrated by Herbert Hoover, a properly qualified engineering executive is inherently well qualified to analyze the government operations, especially those in the field of engineering.

Only fifty percent of Mr. Hoover's recommendations have been adopted, and without any support given him by the national engineering societies. The four large engineering societies have seen fit to establish The Hoover Medal but they have failed to organize themselves so that they could give support to the splendid recommendations that he made in his report.

Of course there are undoubtedly many arguments both for and against having our engineering societies support or oppose political actions. It would be interesting to hear from the readers of PRODUCT ENGINEERING what some of these arguments might be. —G.F.N.

A STUDY MADE AT the Illinois Institute of Technology and based on 194 members of a scientific and technical research organization, indicated three traits characteristic of the more creative individuals—more extensive formal education, disbelief in group effort, and belief in self-determination of deadlines. The report showed the greatest productivity of the individuals was achieved under conditions of about 25 hours a week of assigned tasks, and 17.5 hours of spontaneous, voluntary related home work. The high producers were found to be highly individualistic, and showed a marked tendency to work where they please, when they please. Those who worked the longest hours did not have the greatest productivity.

•

A NORTH AMERICAN B-45C BOMBER with J-47 power plants is undergoing a special jet engine test program for the Air Force by the General Electric Company. The program includes accelerated service life tests of the engines under closely controlled conditions that could not be attained in normal military operations. To date, engine inspection and maintenance have taken less than half the time that would be required with piston engines operating the same number of hours under similar conditions.

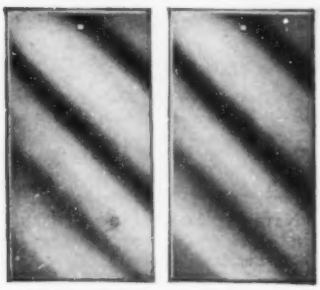
(Advertisement)

Clear Coatings for Zinc and Steel Stand 800 hours' Salt Spray

Increased use of zinc die castings and of zinc-plated steel to replace unavailable materials, combined with the tight supply of copper, nickel and chromium normally used for plating zinc, has focused attention on surface coatings comparable to plating in service performance. Unbiased laboratory tests show that at least two of the clear finishes in the company's line withstand the exceptionally long period of 800 hours' exposure to salt spray and to weatherometer tests.

Effectively protect zinc

These tests demonstrate that DULAC Clear Universal Lacquer #462 and CODUR Clear Synthetic Y743 provide completely satisfactory protection on zinc, zinc plated steel and steel. Even after the unusually severe tests to which these finishes were subjected, there was no indication whatever either of failure of the coating or of discoloration of the zinc.

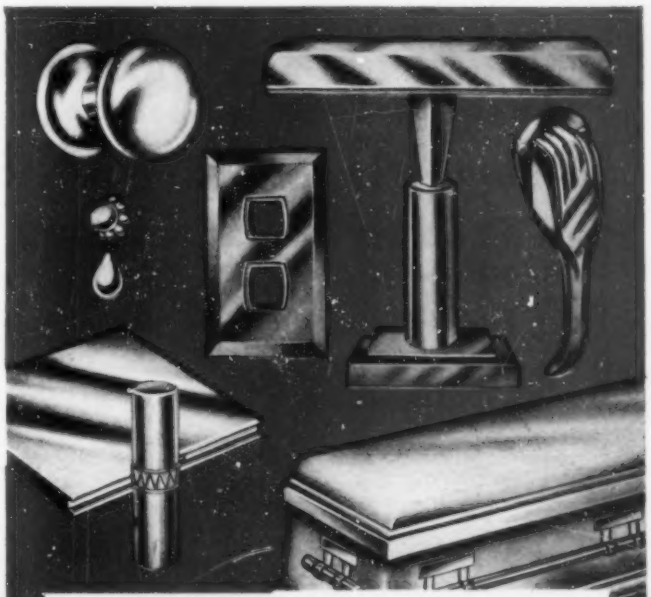


(Left) A zinc-plated steel panel newly coated with DULAC #462. (Right) A similar panel after 800 hours' exposure to salt spray, showing no evidence of attack on the finish.

Adaptability to Drying Schedules

While both finishes give the same performance, DULAC #462 is an air-drying coating, while CODUR Y743 is a baking type. This permits choice of the correct finish to fit into the drying schedules of a particular finishing room.

Technical Data Bulletin #110 on clear finishes is available from Maas & Waldstein Co., 430 Riverside Avenue, Newark, 4, N. J. On request, M & W Technical Service Engineers will discuss specific problems.



NOW! simulate copper, brass and bronze on products like these with

M&W PLATELUSTRE

● Don't let critical metals put a *needless* crimp in your production!

Take zinc or steel—apply a coating of one of the new PLATELUSTRE finishes. You wind up with products and parts that look so much like copper, brass and bronze that *the eye can scarcely tell the difference!*

Whether you have been using now unavailable copper and its alloys for *making* products or for *plating* products, you will find these new M & W finishes *equally* effective in keeping your plant running. There are types for air-drying and baking schedules — pick the one that best fits *your* production requirements.

Let an M & W Technical Service Engineer show you—*right in your own plant*—how easy these PLATELUSTRE coatings are to use, and what striking effects they produce. Or, if you prefer, write for free literature.

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THE MICROCAST PROCESS of precision casting for aircraft engine power blading affords outstanding production economies to design engineers working on those remarkable new power systems. And the reasons for these savings over conventional methods are both unique and exclusive with the process. With Microcastings, you take advantage of the simplicity and inexpensiveness of tooling, avoid tool breakage. You effect substantial savings in expensive, critical alloys. Likewise, you effect man power savings and free equipment and floor space for other necessary operations. Perhaps the Microcast Process can solve some of your production problems; better investigate today!

FREE BOOKLET

on the precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design using the high melting point alloys where surface smoothness and dimensional uniformity are mandatory, requiring little or no machining. Write for booklet and information.

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MEETINGS

October 8-12

NATIONAL HARDWARE SHOW—Grand Central Palace, New York, N. Y.

October 9-12

SCIENTIFIC APPARATUS MAKERS ASSOCIATION—Midyear Meeting, Recorder-Controller Section and Industrial Instrument Section, Seaview Country Club, Absecon, N. J.

October 11-12

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Technical Conference on Fractional Horsepower Motors for Refrigerating Equipment and Pumps, Dayton Biltmore Hotel, Dayton, Ohio.

October 15-19

NATIONAL METAL EXPOSITION CONGRESS—Michigan State Fairgrounds, Detroit, Mich.

October 22-24

NATIONAL STANDARDIZATION CONFERENCE—Second Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 22-24

AMERICAN STANDARDS ASSOCIATION—Thirty-third Annual Meeting, Waldorf-Astoria Hotel, New York, N. Y.

October 22-24

NATIONAL ELECTRONICS CONFERENCE—Seventh Annual Conference, Edgewater Beach Hotel, Chicago, Ill.

October 29-31

AMERICAN GEAR MANUFACTURERS ASSOCIATION—Semi-Annual Meeting, Edgewater Beach Hotel, Chicago, Ill.

November 7-9

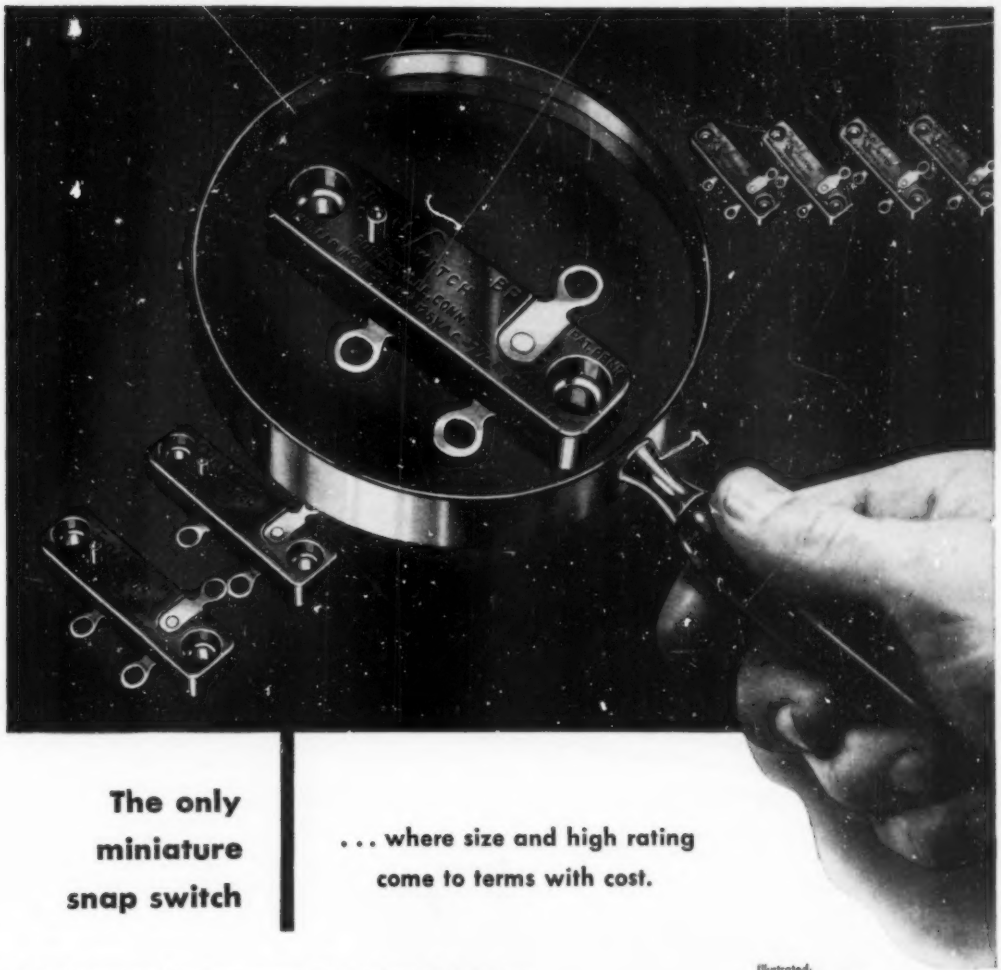
AMERICAN SOCIETY OF BODY ENGINEERS—Sixth Annual Technical Convention, Rackham Memorial Building, Detroit, Mich.

November 8-9

NATIONAL CONFERENCE ON INDUSTRIAL HYDRAULICS—Seventh Annual Conference, Sherman Hotel, Chicago, Ill.

November 19-20

NATIONAL METAL TRADES ASSOCIATION—52nd Annual Convention, Palmer House, Chicago, Ill.



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. . . where size and high rating come to terms with cost.

Illustrated:
Model BP, single-pole, double-throw, 15A., 125 V. A.C. Overall length, 1⅝"

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ENGINEERING ABSTRACTS

The Designers and Formulas

Foreign Abstract from "Designers' Formulas" by W. A. Tuplin, *The Engineer* (London), August 3, 1951, pp. 145 to 147.

IN THE LECTURE ROOM the student who asks for a "formula" at the end of a discourse on the application of mechanical principles to a design problem is rightly chided. In the education of engineers, the object is to impart a grasp of basic principles applicable to a wide variety of subjects and it would be contrary to that aim to devote attention to numerous formulas, each of limited scope.

In practical design, however, the position is quite different. There the designer is presumed to have already acquired a reasonably wide range of technical knowledge and the need is to use it to the best advantage in coping with his daily problems. When dealing with repeated problems of the same general kind, appropriately devised formulas are essential for speed and certainty. They minimize labor, tend to consistency and reduce the chance of serious error. So effective may they be that in many branches of machine design recurring problems are solved reliably and efficiently by people with little technical insight into the theoretical background. In some cases, indeed, the designer's acquisition of all available knowledge on the subject would no more improve his work than would perusal of steam tables to be a help to a locomotive driver.

To be above criticism, however a working design formula must have been intelligently developed to meet the conditions to which it is applied in a sound comprise between convenience and accuracy. It must therefore have been devised by someone who has built experience in the particular class of problem on a foundation of sound knowledge of theoretical origins and practical results.

Not every design problem has been provided with a cut-and-dried solution. In some cases no such solution may be possible; in others no special effort may have been made to produce one by those who might be expected to do so. Possible reasons for the failure of experienced men to devise working formulas are: (a) Inability to devise a satisfactory one; (b) inability to devise one that is 100 percent correct in

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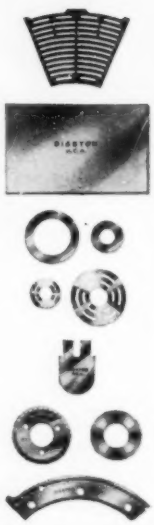

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every possible case; (c) disinclination to admit that long experience in handling any one class of problems can be reduced to a formula; and (d) reflection that there are more lucrative ways of using the fruit of experience than giving it way in working formulas.

In many practical design problems, data essential for a rigorous solution are simply not available and a formula embodying an experienced man's assumed values for items of the missing information is likely to be more reliable than an apparently more refined formula in which the average user must insert his own estimates of unascertainable quantities.

So far as calculation is concerned, designers fall into three main classes:

Class A is content to use a formula that has already had long use by someone else and indisposed to make any critical examination of its origin or limitations; is touchingly faithful to "the way we've always done it", no matter how serious the shortcomings of that way may be shown to be.

Class B is scientifically trained and, at first imbued with the academic aversion to working formulas.

Class C is possessed of theoretical knowledge, practical training, experience in design, ability to devise sound working approximations and conviction that they are necessary as a basis for sound and economical design.

An irrational attitude sometimes found in the Class A designer is the assumption that, because a formula he has used for years has not seriously let him down, no other formula can possibly be reliable, let alone superior. It is an attitude that might, for example, have opposed Whitworth's standardization of eight threads per inch for a 1-in. bolt on the ground that some manufacturer had always secured excellent results from nine threads per inch and therefore that no other number was admissible.

Most design work of a repetitive character is in practice carried out by Class A. Class B, scornful of "formulas" consults the textbooks, makes each design problem into a minor research investigation and after much time and labor produces designs that may not be sound or economical. After a few experiences of this character, the discerning Class-B man begins to understand that there is something to be said for the methods of Class A.

The Class C man has graduated through Classes A and B, appreciates the viewpoints and limitations of both and understands the commercial and technical necessities of formulas for design in industry. Class C is the normal source of reliable design formulas.

The deviser of a working formula

may happen to have written a textbook but (and this is what Class B men have difficulty in recognizing) textbooks are not in general directly helpful in practical design because:

(a) Textbook writers are usually more closely associated with the theoretical aspects of the subject than with the practical ones and may not fully appreciate the value of short, clear-cut design methods.

(b) By the time the author has done all the essential work for a textbook, collecting information from all sources, making it into an ordered sequence, presenting all the alternatives, preparing diagrams, unifying nomenclature, chasing inconsistencies, glossing over weaknesses, disarming criticisms and so on, he has neither inclination nor energy for extending his work to a field where bold approximation is required and rigour is often a handicap.

(c) To show after hundreds of pages of background that the essential solutions of design problems can be compressed into a hundred lines, is something like anti-climax.

Close examination of the theoretical ramifications of a design problem is apt to exclude from the designer's mind such matters as the practical importance of using standard tools and components. Although the advantage of the widest possible application of standard details is not open to serious dispute, those responsible are often reluctant to effect it. It is clearly less trouble for a draftsman to draw details to suit their surroundings in the design without considering existing standards, than it is for him to fashion the whole design so as to use standards to the maximum extent. The sound designer, however, neither scorns to use standards where it is easy nor shrinks from doing so where it is hard.

Synthethic Lubricants

Abstracted from "Some Industrial Experiences With Synthetic Lubricants" by C. H. Sweat and T. W. Langer, Mechanical Engineering, May, 1951.

SYNTHETIC LUBRICANTS are currently used because of unique or superior performance characteristics not found in conventional petroleum lubricants. Several types of synthetic lubricants are now available commercially and, new products are being developed. The fluids discussed in this paper are polyalkylene glycols and their derivatives. These lubricants range in consistency from very light to highly viscous liquids; some water soluble and others insoluble in water.

The properties of polyalkyleneglycol lubricants include excellent anti-

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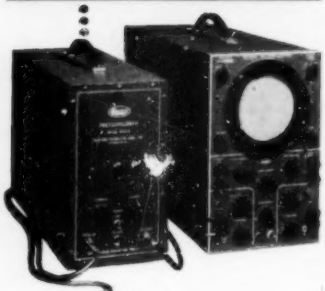

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wear action, good load carrying capacity, favorable viscosity-temperature relationships, low stable pour points, little or no solvent or swelling effects on both natural and various type synthetic rubbers, stability at high temperature, and unusual resistance to sludge and varnish formation.

High Temperature Applications. Elevated temperatures are resisted better by the synthetic lubricants. In the ceramics industry these lubricants have been used to advantage in wheel bearings on rail cars which carry ceramic products through long tunnel kilns. The operating temperature of the roller bearings is 400-500F. As much as 5 months operation without failure was experienced. Less frequent lubrication is required, with subsequent savings in maintenance and material.

Glass fabricators have found these synthetic oils useful in lehr outboard bearings, on gears and chain drives of annealing ovens, and in lubrication of hot-glass cutoff shears.

Other applications in the high temperature field are also discussed in this paper.

Gear Lubrication—Some interesting examples of the unusual antiwear properties of the synthetic lubricants have come from applications involving heavily loaded gears. Typical performance results of one of the applications are listed in the following table:

Comparative Performance Data-Lubrication of Heavily Loaded Speed-Reducer Gears

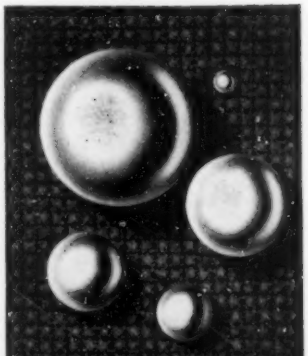
	Using petroleum lubricant	Using synthetic lubricant LB-1200-X
Overhaul schedule	Every 3 months	Every 12 months
Failure between overhauls	Frequent	None
Tooth surfaces at overhaul point	Bronze gear badly worn, worm teeth spalled	Very little wear, no spaling
Deposits at overhaul point	Heavy sludge in case, ball bearings loaded with hard carbon	Practically no sludge, ball bearings in excellent condition

The reduced wear and extended tooth life which frequently result from the use of the polyglycol lubricants with heavily loaded gears suggest that these fluids possess basic lubricity characteristics which differ considerably from those of mineral oils. Under certain conditions they display unusually high film strength or load-carrying qualities which appear to be inherent in their structure.

Metalworking Applications—The good extreme—pressure properties of the polyalkylene—glycol lubricants have been evident in certain metalworking operations, being reflected in prolonged life and better surface finish.

Mold Release Agents and Rubber Lubrication—The little solvent and

a metal ball PROBLEM?



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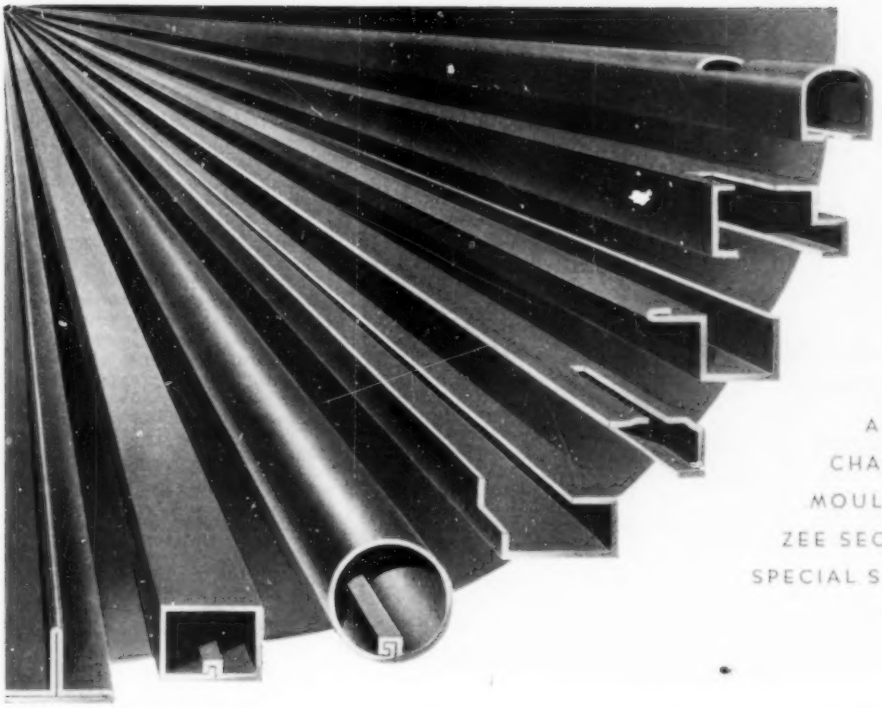

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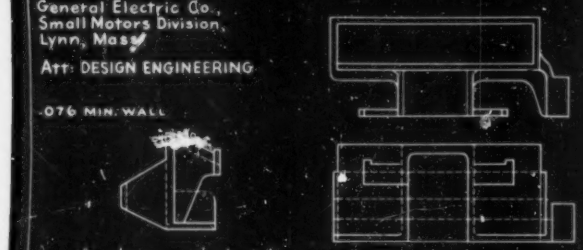

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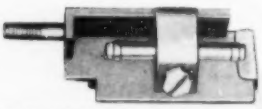
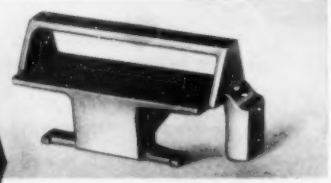
The production of a light weight, rugged brush holder for use with aircraft generators posed a problem for General Electric. They wanted a high-quality, rigid brush holder at reduced cost, produced by a process that afforded closer control of tolerances.

Atlantic was consulted and the recommendations they made on the brush holder design provided more than ample strength. The Atlantalloy process provided the close tolerances and lower cost.



Old brush holder designed by General Electric for use on aircraft generators.



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swelling effect of the polyglycol—fluids on most natural and synthetic rubber compositions make them suitable as mold release agents and as lubricants for tire air bags, seals, gaskets, knives and other cutting tools used in the rubber industry. The benefits experienced have been longer life of air bags, cleaner breakaway and insignificant build-up on the mold and neater product formation.

Internal Combustion Engine Lubrication—The good lubricating quality, cleanliness and solvent action of the polyglycol fluids for petroleum residues have been used to advantage in internal combustion engines. Industrial tow and lift trucks are especially prone to form sludge with mineral oil. The comparative experience of one company is summarized in the following table:

Comparative Performance in Tow- and Lift-Truck Service

	Using premium-grade oil	Using polyalkylene-glycol-type lubricant
Average overhaul period, months	5 to 6	Over 17
Wear of rings, cylinders and bearings	Normal	Normal
Ring sticking at overhaul	Excessive	None
Cleanliness at overhaul	Badly sludged	Slight deposit in pan and valve chamber
Smoking	Obnoxious as used for overhaul approaches	Negligible throughout service
Lubricant change period, weeks	1	26 to 52
Lubricant make-up	Increases to 2 qt. per day by 6-mo. overhaul period	Averages approximately ¼ pt. per day at start and still less than 1qt. per day at 27-30 months

Synthetic Greases: Many interesting applications have been developed for synthetic greases. In dry cleaning equipment one of these greases gave longer service than the conventional type because of its high temperature stability and greater solvent resistance. In another application, belts on plastic extruder dies operated at elevated temperatures were easy to run when the threads were lubricated with a synthetic grease containing 10 percent molybdenum disulphide.

Hydraulic Fluids—Synthetic lubricants are proving to be superior hydraulic media or components of hydraulic fluids because of favorable viscosity—temperature characteristics and good stability. Large volumes of polyalkylene-glycol products are being used in automatic hydraulic-brake fluids, brake-parts dunking compounds, and industrial hydraulic operations.

The properties and examples of specific applications of thin hydraulic fluids and of the non flammable Hydrolubes are covered in this paper.

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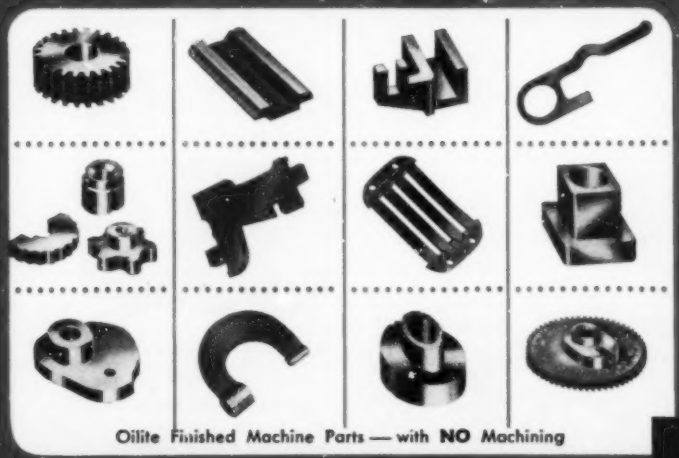

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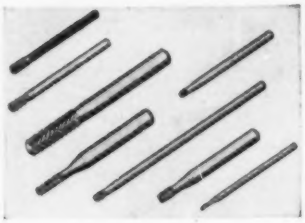

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OUR READERS SAY

An Echo from England

To the Editor:

In reply to the mechanism problem that was given in PRODUCT ENGINEERING, May 1951, p 288, I have some ideas which might be useful.

The movement of the wheel relative to the ring appears to be quite arbitrary, and not given by a kinematical law. Therefore, the first suggestion is to insure the movement of the wheel by a cam, with as many lobes as reversals of the wheel are necessary (Fig. 1). The contact between follower roller and stationary cam plate will be maintained either by a spring (force closure) or by a grooved cam (form closure). The follower arm (3) is rigidly connected with the wheel (2), the wheel itself suspended on the anticlockwise rotating arm (1). The fixed cam plate is shaped according to the motion required, small variations of the angle are possible by shortening or lengthening the arm (1) or by making parts of the cam adjustable.

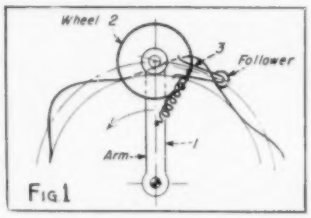

FIG. 1

If a kinematical relation exists between the movement of the wheel (2) and the rotary movement of the arm,

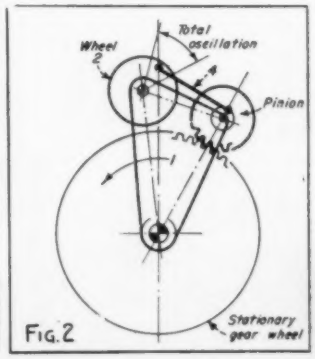

FIG. 2

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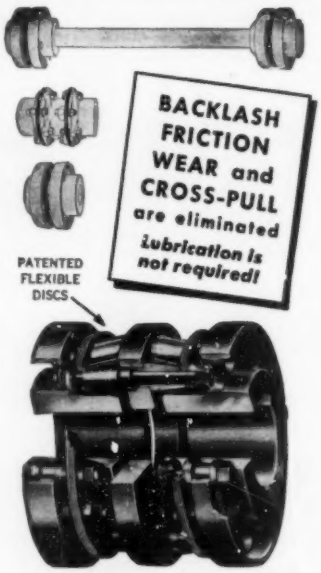

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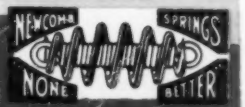


then other mechanisms would become available. For instance, as in Fig. 2, the control of the movement could be according to a cycloidal path. In this case, the wheel is again suspended on arm (1), but this arm would have a third pivot for a pinion in mesh with a stationary outer (or inner toothed) wheel. Now the wheel body would be connected with pinion by a coupler (4). This linkage would represent a rotating crank mechanism, which would produce periodical oscillations of the wheel. Variations in a given mechanism are possible by varying the lengths of the links.

—P. GRODZINSKI
London, N.W. 3.

Largest Motor is G.E.'s

To the Editor:

On page 166 of your July issue you failed to give the reader what to my mind is the most important fact concerning the "Largest Motor Ever Installed", which should be brought to your readers attention. The caption fails to mention that this largest motor is the product of the General Electric Company and we fellows of G. E. are mighty proud of it.

—K. R. M.
Schenectady, New York

Ed—The most grievous mistakes are often errors of omission. Our apologies to the men of General Electric who designed and built the 65,000 horsepower giant motor now installed at the Grand Coulee Dam on the Columbia River.

Brass Plating Aluminum

To the Editor:

In the "Our Readers Say" column of the May issue, we noted a letter from Mr. W. J. Horvereid of Minnesota Rubber & Gasket Company concerning brass plating of aluminum. In reply to this letter you have indicated that no company has successfully developed a process for brass plating of aluminum. We would like to point out that our Alumon process has been in use now for several years for brass plating on wrought aluminum and permanent mold cast aluminum products. One of the larger manufacturers of brass plated household hardware in the east converted from cast iron to permanent mold cast aluminum for such items as coat hooks, door stops, and window locks approximately 3 years ago and has been barrel brass plating these cast aluminum parts ever

since that time. More recently, several manufacturers of door knobs and similar items have converted to the use of sheet aluminum in place of sheet brass and are brass plating these sheet aluminum items. These brass plating operations are, of course, for decorative purposes only. However, there is no reason why other alloys of brass could not also be plated on the aluminum. Even if the brass solution itself is such that it could not be plated directly over the Alumon film, it would always be possible to apply a very thin copper flash coating and follow this with the proper brass deposit. —HUBERT M. GOLDMAN
Enthrone, Inc.

Formula For Figuring Angles

To the Editor:

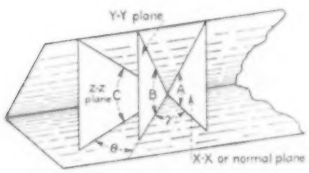
In the June issue of PRODUCT ENGINEERING there is an article on Resolution of Angles. From time to time we have to figure resulting angles, and we would like to have the formula that you used for doing the figuring.

We calculate these angles in a way that takes too much time and feel that your arrangement of equations may do the job more quicqly.

—W. WALLACE MCKAIG
Cumberland Steel Company

Ed—The diagram and equation on which the chart for the resolution of angles was prepared appears below. This material was obtained from the design handbook from one of the large aircraft companies and we hope it serves your purpose.

$$\tan B = \tan A \cos \gamma$$



Any Old Reprints?

To the Editor:

Do you have available 25 copies of your reprint "Plain Sleeve Bearings—Material and Design" which appeared in the October 1948 issue of PRODUCT ENGINEERING. M. D. GJERDE
Standard Oil Company

Ed—We do not have available 25 copies of our reprint "Plain Sleeve Bearings—Material and Design". As a matter of fact, if you were to ask

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a WELL-CAST lightweight magnesium or aluminum casting is your ready answer
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for one, we would have a lot of difficulty in obtaining it for you.

Perhaps you can have the article photostated. We should be glad to extend permission for you to have a limited number of photostated copies made. If you so desire, we could do this for you ourselves, but in general, our prices are much higher than if you had it done on the outside.

Delayed Reaction

To the Editor:

An illustration of an electronic comparator on page 166 in the July 1949 issue of PRODUCT ENGINEERING, listed the Merz Engineering Company, Indianapolis, Indiana, as the manufacturer.

A recent inquiry disclosed that they do not manufacture such equipment and we are wondering whether you would be kind enough to check and advise us from whom literature covering this equipment can be obtained.

—E. F. CLEMENS
Miehle Printing Press & Mfg. Co.

Ed—All of our records show that the electronic comparator described in the July, 1949 issue of PRODUCT ENGINEERING was manufactured by Merz Manufacturing Company, Indianapolis, Indiana. So far as we can tell from the nameplates on the equipment, this is correct. Unfortunately, all our files are destroyed after six months, and so we have no detailed record other than what we have told you on this new equipment. As a matter of fact, the name on the equipment is "Merz Pico Surface Comparator."

We're Over Here

To the Editor:

Thank you very much for the story about our Type "C" Motor Starter on page 190 of your August issue.

The correct address is The Clark Controller Company, 1146 East 152nd St., Cleveland 10, Ohio, instead of "1146 East 152nd St., New York, N. Y." as shown.

—ERNEST C. ROBERTS
The Clark Controller Company

Fresh Copy Delivered

To the Editor:

In view of its condition I cannot accept delivery of the enclosed copy of PRODUCT ENGINEERING, April, 1951. Kindly send me a fresh copy. Per-

haps it would be well to place it between boards and mark the envelope "Do Not Fold".

Fortune magazine comes to me boxed, and is it as good as PRODUCT ENGINEERING? —H. F. PETERSON
Rockford, Illinois

Ed—Under separate cover we are sending you another copy of PRODUCT ENGINEERING for April. Unfortunately it sometimes happens that an issue is banged around in the mails.

We have made several tests on different methods of mailing and have found that in terms of cost as well as efficiency, our present method is the best. If you receive additional copies that are not to your satisfaction please contact us directly.

In reference to your last paragraph, Fortune is pretty good but there is really no comparison.

Corrections in Circular Nomogram Article

To the Editor:

The typography was excellent for my article "Circular Nomogram Theory and Construction Technique", PRODUCT ENGINEERING, August 1951, page 152. Of all the possible places for errors to creep in, the following were found after a careful search:

1. In the numerator of Eq (4) on page 153, the fraction line was omitted between the L and the beta.

2. The fraction line was omitted in the derivative on the second line of the first column on page 154 and there should be no exponent 7 as shown.

3. The numerator in the upper equation to the right of the nomogram of Fig. 5 should be 114.6 instead of 229.2 to agree with Eq (12).

—E. C. VARNUM
Barber-Colman Company

Where Can I Get It?

Rubber Bonding Process

To the Editor:

We would like to have the name of the company that operates the Metal to Rubber Bonding Process which was announced in the June issue of PRODUCT ENGINEERING in the Highlights section, page nine.

We would appreciate having, also, the name of the manufacturer of the portable instrument which measures

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B ETTER PRODUCTS
C AT LOWER COST
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Electric Resistance
WELDED
STEEL
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ROUND
⅜" to 4" O. D. 9 to 22 gauge
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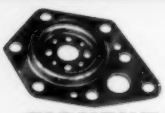

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MECHANICAL LEATHER PRODUCTS

the thickness of non ferrous layers on ferrous bases also announced in the June issue. —JOHN S. FISHER
General Metals Powder Company

Ed—Our source of information on the Rubber Bonding Process was the U. S. Patent Office, Washington, D. C. and information on the portable instrument which measures the thickness of non-ferrous layers on ferrous bases was obtained from the General Electric Co., Ltd., Magnet House, Kingsway, London, England.

Translucent Drawing Paper

To the Editor:

On page 5 of the July issue of PRODUCT ENGINEERING there is an article about translucent drawing paper.

Where can we get more information about this item. —F. J. SAXTON
Tresco Inc.

Ed—Our source of information on this product is Eastman Kodak, T. R. Bldg., 343 State St., Rochester 4, New York.

Tiny Potentiometer and Test-Point Jack

To the Editor:

In the Highlights section of the July issue of PRODUCT ENGINEERING we note mention of a "test-point jack", and a small drum type potentiometer. Where can these items be procured? —HENRY D. HALL
Laboratory For Electronics, Inc.

Ed—The "test-point jack" and "tiny potentiometer" mentioned in the Highlights section of our July issue may be procured from: Allen Products Co., 117 N. Main St., Brockton 4, Mass. for the "test-point jack"; and G. M. Giannini & Co., Inc., 254 W. Colorado St., Pasadena, Calif. for the "tiny potentiometer."

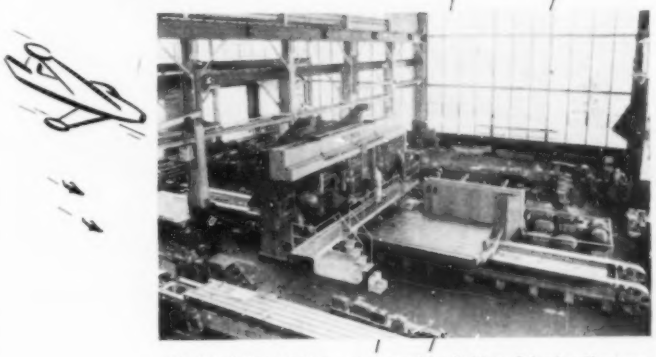
Awards Not Compiled

To the Editor:

I would appreciate your advising me where I can get the following information: how many concerns received the five Army/Navy "E" Awards during last war? That would be the flag and four stars. How many concerns received just the flag? Number of concerns that received one star, two stars, etc. —GUSTAV NYSELIUS
Mt. Vernon Die Casting Corp.

Ed—As far as we can discover, any

The world's biggest SKIN MILL



This Skin Milling Machine, manufactured by Giddings & Lewis, will cut one-piece wing sections, employs Twin Disc Clutches as the engaging mechanism.

Whole wing sections, whole fuselage sections, in one piece. That's the role of this HYPRO Skin Milling Machine in speeding production of F-94 jet fighters.

Manufactured by Giddings & Lewis for Lockheed, it will automatically cut and shape a predetermined three-dimensional pattern—laterally, longitudinally, and to the proper thickness. And it will handle work weighing up to 150 tons.

In this tough but delicate operation, as in so many Giddings & Lewis machine tools, Twin Disc Clutches engage and disengage the power. The Skin Mill employs two clutches—Twin Disc Model MTU Machine Tool Clutches—the kind employed today by more machine tool manufacturers than any other clutch . . . because of their high torque capacity, compact construction, instant release and resistance to centrifugal action. For complete information about Twin Disc Machine Tool Clutches, write today for Bulletin No. 134-A.

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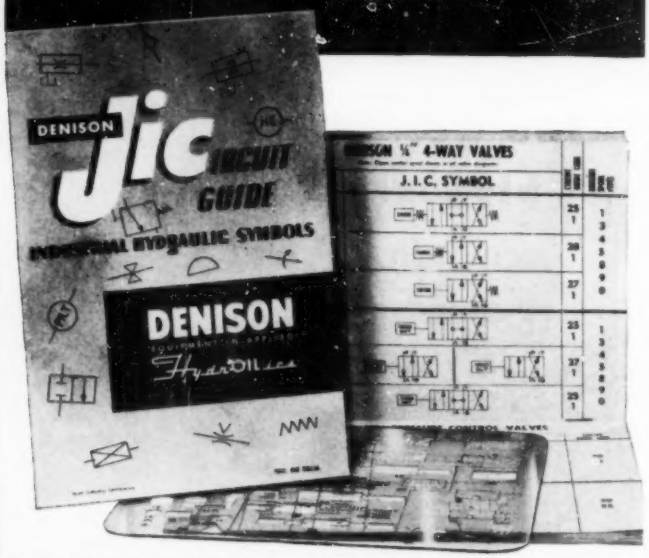

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DENISON HydrOILics

compilation of the production awards made during World War II has never been published.

During the war this activity was handled by the Army-Navy Board for Production Awards, a division of the Office of the Secretary of War. The Industrial Services Division now has in its custody all records of this kind from World War II.

During the last war and ending in September 1945 *Business Week* magazine printed weekly lists of awards made. The only way to tell from this source how many awards have been won would be to tabulate the number of mentions in the various issues.

Black Finish for Low Carbon Steels

To the Editor:

We would like further information on the "black finish for carbon and low-chromium steels" referred to in Highlights section of your March issue. —F. O. BLACKWELL, JR.
Lamson Corporation

Ed—Our source for information was the Atomite Black Company, 547 Washington Blvd. of Chicago 6, Illinois. By contacting these people, you will be able to receive any data on this item you desire.

Coatings for Small Parts

To the Editor:

In the June 1951 issue of PRODUCT ENGINEERING was an article entitled "Porcelain Enamel Coatings". We would like to have references on sources of such coatings for small parts. —FERN DITZLER
Micro Switch

Ed—For further information on sources of coatings for small parts we suggest that you write to the Porcelain Enamel Institute, 1010 Vermont Ave., N.W., Washington, D. C.

Titanate Dielectrics

To the Editor:

In your May issue on page 163 you have an article covering Titanate Dielectrics. Do you know where a sample of this could be purchased?
—J. W. DEBARR
Albarr Products Co.

Ed—Titanate Dielectrics is a development of Bell Telephone Laboratories. We suggest that you get in touch with that organization.

NEW BOOKS

Static and Dynamic Electricity

WILLIAM R. SMYTHE, *Professor of Physics, California Institute of Technology. 616 pages, 6 x 9 in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y.* $8.50.

The book is designed to train first-year graduate students in physics, electricity and magnetism. This book will also provide a reference where workers in these fields may find the methods of attack on those problems, common in research, for which the formulas in the handbooks are inadequate. It is assumed that the reader has a reasonable familiarity with vector analysis, the calculus, and elementary differential equations. This book is written for the experimental research physicist and engineer rather than for the theoretical man. For this reason, only that theory which has applications is included. This is developed by the most concise method compatible with the assumed preparation of the reader. No subject is included for its historical interest alone. More than the usual number of problems have been worked out in the text, and these have been selected for one or more of the following reasons: The result has important applications, it clarifies the theory, it illustrates some useful mathematical device, it proves the utility of some concept in the theory. At the end of each chapter is an extensive collection of problems involving nearly all the theory in the text.

Some of the chapters included are: Basic Ideas of Electrostatics, Capacitors, Dielectrics, Systems of Conductors, Magnetic Interaction of Currents, Transient Phenomena in Networks and Plane Electromagnetic Waves. Each chapter is developed logically in relation to the material preceding it.

The Nature of Polyphase Induction Machines

PHILIP L. ALGER, *consulting engineer, Small and Medium Motor Divisions, General Electric Company. 397 pages, 6 x 9¼ in. Published by John Wiley & Sons, Inc., New York, New York and Chapman & Hall, Ltd., London, England.* $7.50.

Reflecting the author's thirty years of experience in the design of electric motors and generators, The Nature of Polyphase Induction Machines offers a

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thorough understanding of the behavior of the simplest and most widely used form of electric machine. The polyphase induction motor is the workhorse of American industry—it provides nine-tenths of the power that lengthens the arm of the American worker some eight horsepower per man.

The author carries the concept of energy being received, stored, transformed, and delivered through all aspects of motor performance. Complete and accurate formulas are given for reactance, power factor, torque, and magnetic forces; and methods for calculating locking, crawling, magnetic noise, and voltage ripples are provided. The results are presented in algebraic formulas and equivalent circuits, with few symbols, and adequate references to more specialized articles.

The analysis starts from the sophomore level of mathematics and physics, and it ties in at the end with the generalized machine concepts of Gabriel Kron. In the eleventh chapter, the conclusions derived from theory are compared with practice in American industry, and brief summaries are given of the American Motor Standards. In this way, the book opens to the reader all aspects of electric machinery design and application.

Servomechanisms and Regulating System Design, Vol. I.

HAROLD CHESTNUT *and* ROBERT W. MAYER, *both of the Aeronautics and Ordnance Systems Divisions of the General Electric Co.* 505 *pages,* 6 x 9 *in. Published by John Wiley & Sons, Inc.,* 440 *Fourth Ave., New York* 16, *N. Y.* $7.75.

For some years the material contained in this and its companion volume, which is to follow, has been presented to General Electric engineers of the aeronautic and ordnance system divisions and of the technical education programs.

This book, Volume I, is adapted to the needs of engineers and engineering students who have not had previous training or experience in the field of closed-loop control systems.

Since the solution of linear differential equations during both transient and steady-state operation is important to an understanding of control system performance, this subject is presented briefly from the operational and Laplace transform points of view. Circuit theory and system stability are also presented because of their importance as background material.

The nomenclature and symbols re-

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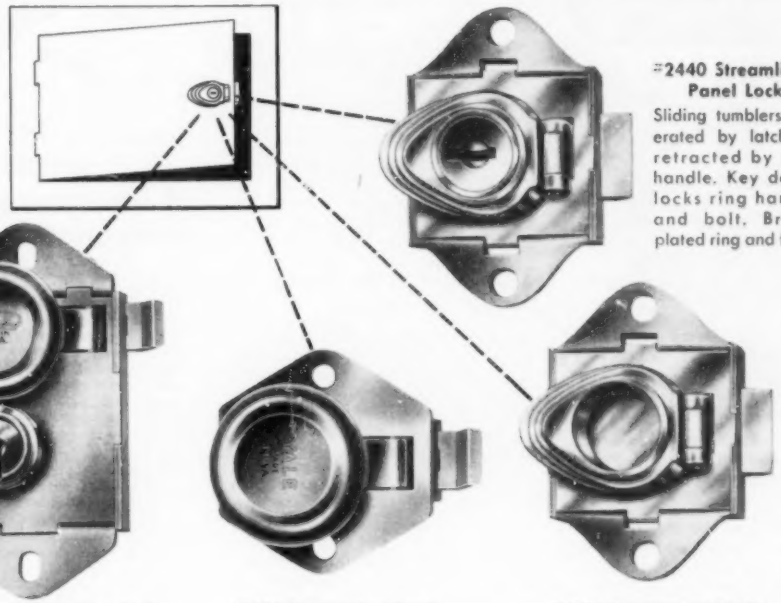

#2440 Streamlined Panel Lock
Sliding tumblers operated by latchbolt retracted by ring handle. Key deadlocks ring handle and bolt. Bright plated ring and face.

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Key deadlocks bolt and ring handle which retracts latchbolt to operate. Lever tumbler mechanism. Bright plated ring handle and nose.

#2435 Companion Catch
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#2445 Companion Catch
Reversible for either right or left hand opening doors. Ring retracts latchbolt to operate. Bright plated ring and face.

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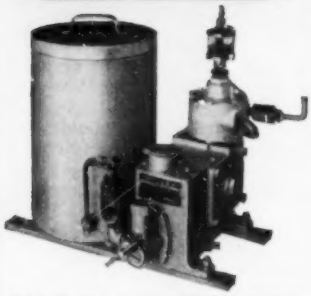
run on gas pressure to drive liquid pumps!



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cently recommended by the A.I.E. sub-committee on Symbols for Feedback Control Systems are used throughout the book.

Following the presentation of the necessary mathematics and explanation of the nature of the physical problems associated with feedback control, the authors discuss typical control elements and their transfer functions, complex plane representation of feedback control system performance, design use of complex plane plot to improve system performance, attenuation concepts for use in feedback control system design, application of attenuation-phase diagrams to feedback control design problems, multiple-loop and multiple-input feedback control systems, and comparison of steady-state and transient performance of servomechanisms.

To extend the usefulness of the book to under-graduate and graduate students, numerous problems are included that illustrate and extend the material presented in the text.

ASTM Manual On Quality Control of Materials

Prepared by ASTM *Committee E-11 on Quality Control of Materials, Special Technical Publication 15-C.* 100 *pages, 6 x 9 in., heavy paper cover, American Society for Testing Materials, 4916 Race St., Philadelphia 3, Pa.,* $1.75.

This new manual is organized in three parts. Part 1 represents a revision of the main section of the former ASTM Manual which it replaces. This section discusses the application of statistical methods, other problems of condensing the information contained in a single set of n observations, and presenting essential information in a concise form. Special attention is given to types of data such as would be gathered by individuals or committees and presented to the Society, with emphasis on the variability and the nature of frequency distributions of physical properties of materials.

Part 2 represents a revision of Supplement A of the old ASTM Manual which it replaces and discusses the problem of presenting limits to indicate the uncertainty of the average of a unique sample of n observations. In this part is suggested a form of presentation for use when needed in ASTM reports and publications. The restricted conditions under which this form is theoretically applied are given and the meaning of such limits is explained. A table is given to permit ready calculation of 99, 95 and 90

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percent "confidence limits" for various sample sizes. Working rules are presented regarding the number of places to be retained in computation and presentation of average, standard deviations and "confidence limits". In this revision the generally accepted term "confidence limit" is introduced, and constants for computing 95 percent limits are added.

Part 3 presents formulas, tables and examples useful in applying the control chart method of anlysis and presentation of data as mentioned. This method requires that the data be obtained from several samples or that the data be capable of subdivision into subgroups on the basis of relevant engineering information. The principles of this part are discussed largely in terms of the quality of materials and manufactured products.

A New Theory of Gravitation

JAKOB MANDELKER, *assistant professor of mechanics, Georgia Institute of Technology. 25 pages, 5½ x 8½ in. Published by Philosophical Library, 15 E. 40th St., New York 16, N. Y. $2.75.*

This book deals with the development of a new theory of gravitation that harmonizes with the polar nature of electrostatic and electromagnetic fields. The author's approach to this problem is based on the premise that radiation is a manifestation of force directly opposed to gravitation.

The author proposes the concept of "Universal Suction", that is, the escape tendency of matter. He illustrates Nature's provision for holding matter together by gravitation. The conception of gravitation as the correlated counter force to radiation solves a problem that has baffled astronomers and scientists for many centuries.

The scope and content of the book is indicated by the following chapter headings: Concept of the radiating mass density; Relation between matter-energy and gravitation; Theoretical derivation of the gravitational constant; Gravitation, radiation, and atomic dimensions; Natural system of physical units; and The possibility of a New World conception.

Bosch Und Der Dieselmotor

Published by Robert Bosch GMBH Stuttgart, Dept. PLI 4 Postfach 50, Breitcheidstr 4, Stuttgart—W, Germany. 72 pages, 6¾ x 9¾ in.

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will be interested in this very well presented 72 page story of the development of the Bosch fuel injection pump used on diesel engines. The book is a work of art, extremely well illustrated and clearly written. It includes the historical development of internal combustion engines as well as the development of the Bosch fuel injection system. The book commemorates the completion of the one millionth fuel injection pump at the Stuttgart-Feuerbacher works of the Robert Bosch Company.

After a brief two page resume of the development of the internal combustion engine, the book then goes through the development of the various ignition systems and fuel injection systems. Following this, the book presents the historical development of the various types of Bosch fuel injection pumps and valves as applied to diesel engines. The concluding pages of the book are devoted to illustrations and description of the manufacturing and inspection processes at the Bosch works.

Anyone interested in the design and development of diesel engines will find this book extremely interesting. Copies can be obtained by writing Robert Bosch GMBH at the above address.

Introduction to Heat Transfer

AUBREY I. BROWN *and* SALVATORE M. MARCO, *Department of Mechanical Engineering, the Ohio State University, second edition. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y.* $4.50.

The original object in writing this book, namely, to provide an introduction to the subject of heat transfer suitable for use as an undergraduate textbook and as an aid to engineers in practice, has been kept in mind in the preparation of this second edition.

Solicitation of the opinions of users of the first edition has revealed that although a few suggest a more advanced or rigorous treatment of the subject by earlier introduction and greater application of the unsteady-state considerations, the majority opinion definitely favors keeping the treatment at the same level as in the former edition. The authors have therefore endeavored to adhere to this opinion with the hope that for many this introduction to the subject will serve as a foundation for more advanced study.

A revision of this book has been made desirable partly by the appearance of new data on the thermal conductivity and viscosity of air and other

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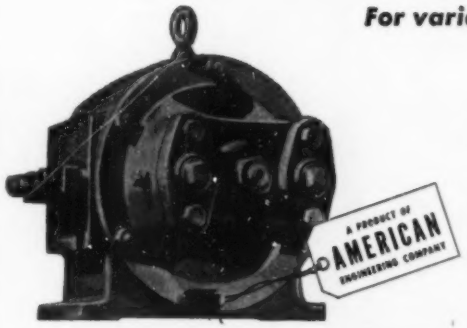

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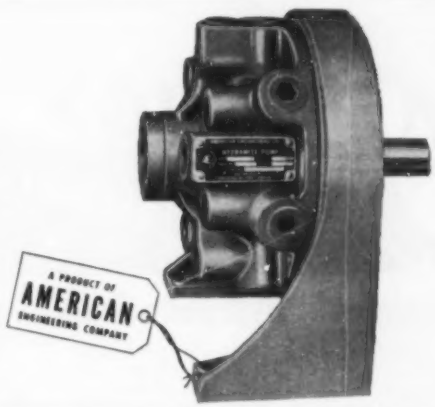

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gases whose properties are involved in many problems of heat transfer by convection. In view of an increasing application of the relationship between fluid flow and heat transfer, need has been felt for additions to the material on fluid flow. Additions have been made also to the chapters on conduction and radiation, particularly relating to the characteristics of insulating materials and to calculations of solar radiation. Several changes in nomenclature have been made in order to conform more closely to current standards. Throughout the book where experience in the classroom has shown the need for clarification, the attempt has been made to improve such portions; and the number of practice problems at the end of chapters has been more than doubled.

Report Preparation

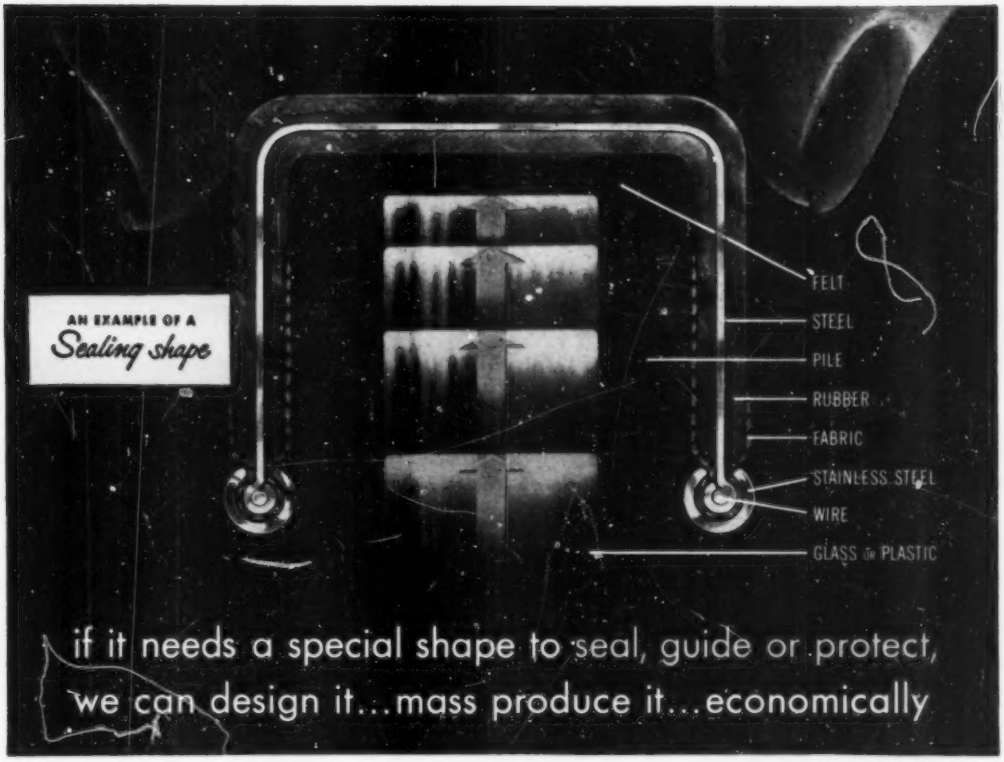
FRANK KEREKES, *Assistant Dean of Engineering and* ROBLEY WINFREY, *Professor Civil Engineering, Iowa State College. 449 pages 8 x 11 in. Published by The Iowa State College Press, Iowa.* $6.90.

The report is a standard tool for transmitting ideas. How to shape this tool for particular applications and how to use it effectively may be learned through study and practice. This book has been developed to assist men in many fields of activity to acquire skill and effectiveness in the preparation of reports.

Stress is placed on the preparation of the typewritten, handmade report, which is the original form of every written report whether or not it is later printed or duplicated by other means. The important basic skills are encountered in the preparation of the typewritten copies. Once these copies are completed, the additional work of duplication is largely mechanical. However, one who is familiar with the processes of duplication can facilitate the publication of his report by anticipating the needs of the duplicating process employed.

A comprehensive treatment of English and composition is omitted. Although the authors stress the importance of correct, clear, concise and convincing expression, they have approached the preparation of reports on the basis that the skill of writing is but one of the basic tools.

Report preparation is a specialized application of communication which, in addition to English, uses important and specialized techniques in the collection of data, in the assimilation and analysis of the pertinent information, in the exercise of discriminating judg-



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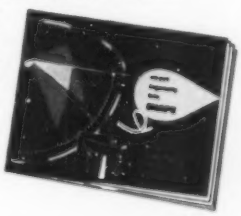

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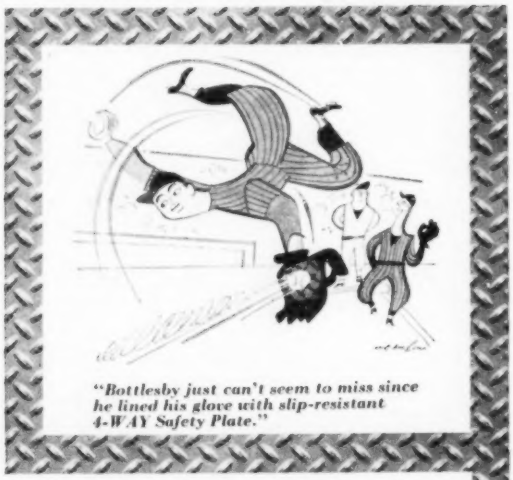

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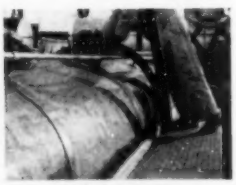
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ment, and in the expression of ideas by graphic and mathematical systems. Therefore, the emphasis is upon the complete process of preparation rather than upon the single skill of writing.

Typical chapters include—Planning the Investigation and Report, Collection of Information, Format and Arrangement, Tabular Presentation, Preparation of Illustrations, and Magazine Feature Articles and Technical Papers.

Plant Layout

JOHN A. SHUBIN, *economist and management consultant; and* HUXLEY MADEHEIM, *consulting engineer.* 433 *pages,* 6 x 9 *in. Published by Prentice-Hall, Inc.,* 70 *Fifth Ave., New York* 11, *N. Y.* $7.35.

This volume brings together in a single book the principles, techniques, and procedures connected with the selection and layout of plant facilities.

Plant layout engineering is described as the task of solving the problems facing manufacturing plants when needs arise for creating additional output capacity, for modifying existing facilities to produce new or redesigned models, and to reduce production costs in order to meet competition and maintain profitable operations.

Such related considerations as economic change and growth, the characteristics of industrial processes, plant location, product design, technological advance, and equipment replacement problems are carefully integrated in the subject matter.

Although materials handling and building considerations are discussed in the procedure of layout analysis, additional emphasis is placed on these topics by devoting separate chapters to each.

Numerous diagrams, photographs and case studies are presented to illustrate the wide applications of the principles and practices discussed.

This text is written for students of engineering and management, and all those concerned with the various phases of manufacturing operations. The material is organized in a logical manner so that the reader can grasp naturally and comprehend the principles and practices associated with plant layout problems.

Materials Handbook

GEORGE S. BRADY. *Revised 7th Edition.* 913 *pages. Published by McGraw-Hill Book Co., Inc.,* 330 *W. 42nd St., New York* 18, *N. Y.* $8.50.

This handbook presents pertinent facts on engineering materials—

metals, alloys, refractories, abrasives, woods—all arranged and indexed for ready reference. Practical data on approximately 9,000 materials provides a vast store of useful information on selecting and specifying materials.

Rather than giving an exhaustive threatise on each material, this manual concentrates on supplying the most essential and useful facts. It is particularly beneficial for purchasing agents, engineers and executives who are constantly interested in the chief characteristics, comparative data, sources, substitutes, adulterants and uses of the materials.

Included in this volume are patented and trade-named materials to present a more specific understanding of commercial applications.

Another feature of the book is the presentation in Part II of valuable economic data, including the economic geography of materials resources, weights, measurements and physical comparisons. These compilations will help clarify the materials picture for purchasing agents especially.

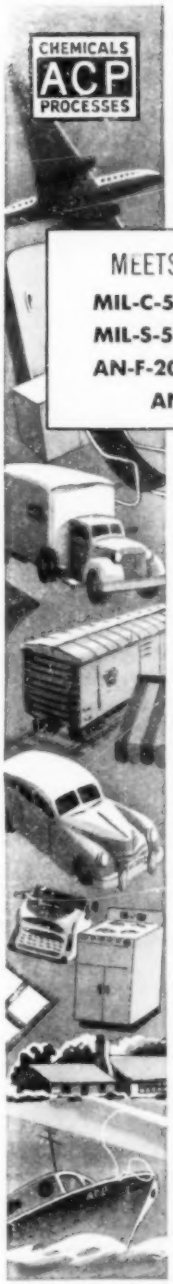
Product engineers will find this book valuable since they are called upon to think in terms of a wide variety of materials. The author has discarded data that are not of practical value and compresses the information in small areas.

The materials are listed and discussed in alphabetical order to simplify locating them. The general discussion of each material covers a definition and description of the material, its specific properties and uses.

Design of Machine Members

ALEX. VALLANCE, *late Chief Designer of Reed Roller Bit Co., and* PROF. VENTON LEVY DOUGHTIE, *University of Texas.* 500 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc.,* 330 *W.* 42*nd St., New York* 18, *N. Y.* $6.

This third edition has been prepared for students or industrial designers who have had some training in Kinematics, mechanics, and factory processes. It includes only a brief review of engineering materials and basic stress and strain analysis. Emphasis has been placed upon the presentation of current design information on subjects that are believed to be most useful for design engineers. The selection of topics presented is debatable. The material available on the subjects selected is often voluminous and in some cases controversial. In order to include as much information as possible without increasing the size of the book, it was found necessary in some



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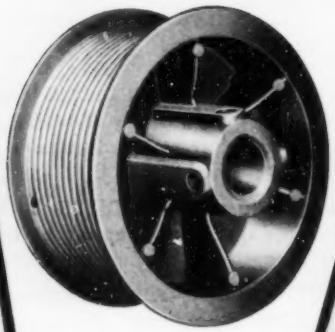

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cases to present conclusions without giving all the detailed steps.

The book apparently is not intended as an advanced theoretical text; it offers a balance between theory and practice. All the chapters have been revised and in many cases rewritten to bring the material up to date.

Changes in the new edition include: Consistent and standard notation is used wherever possible; new material is provided in the chapters dealing with stresses, riveted joints threaded fastenings, power screws, gears, and hoisting and power chains; expanded presentation and more logical treatment of endurance limit, eccentric loading, columns, structural riveting, etc.

A considerable number of illustrations and problems have been added. The problems are intended to give the student practice in applying the principles discussed and to stimulate the thinking of the student. It is brought out that often there is no one answer to a design problem and also that there are problems that have no answers.

Viscosity and Plasticity

E. N. DaC. ANDRADE, *Quain Professor of Physics, University of London.* 82 *pages,* $5\frac{1}{2}$ x $8\frac{3}{4}$ *in. Published by the Chemical Publishing Co., Inc.,* 212 *Fifth Ave., New York, N. Y.* $2.25.

This volume consists of three lectures given by the author as the fifth series of Post Graduate Lectures arranged by the London section of the Oil and Colour Chemists' Association. In it, the author presents a purely academic approach to various difficult and involved technical aspects of viscosity and plasticity without duplicating material that can be found in current books and literature.

Lecture I, begins with a general discussion of the types of flow that leads into the fundamental conception of viscosity and also kinematic viscosity. It is proposed that if the frequency of the fundamental vibration, the mass of the molecule, and distance between adjacent molecular layers are known, it is possible to find an approximate value of viscosity of a liquid, by considering the rate of communication of momentum from layer to layer. This makes it possible to estimate the viscosity of a liquid from properties found in tables of physical constants. Formulas for evaluating this approximate viscosity are included and also for the variation of viscosity with temperature.

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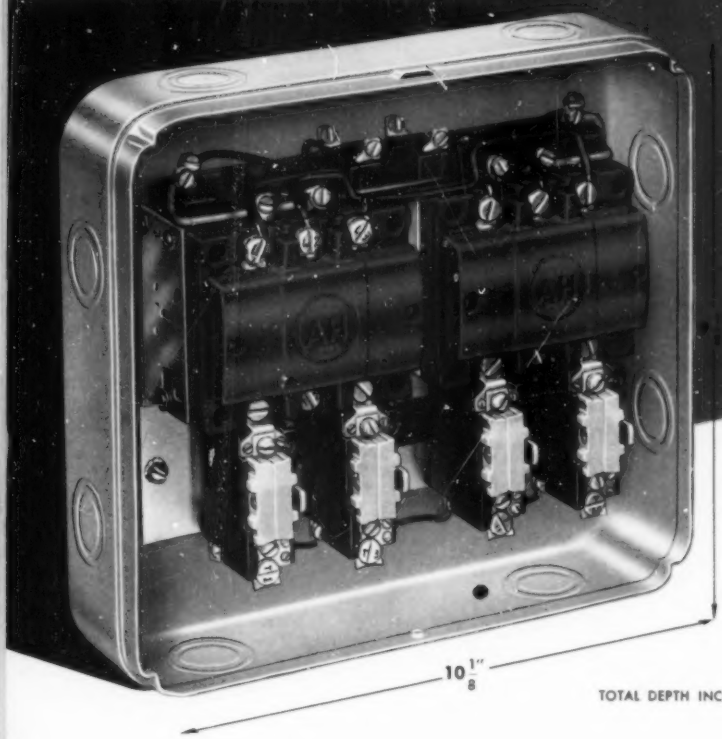

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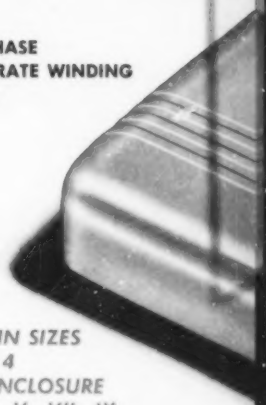

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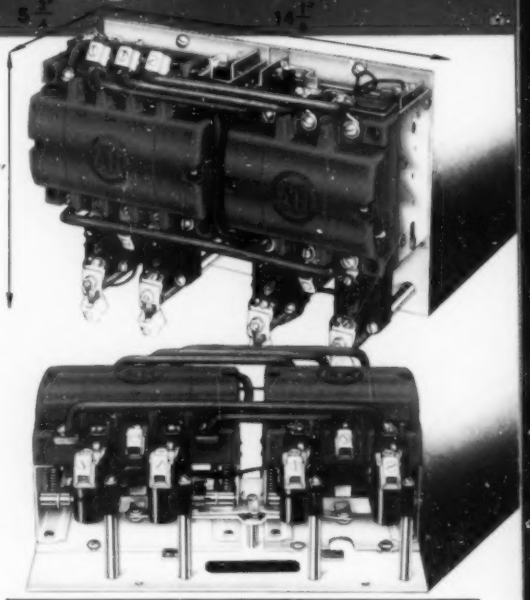
SIZE 3 — 2 speed reconnected winding — 3 phase, note location of positive interlock (in "OFF" position). Wiring diagram points up simple straight-thru front wiring with vertical overload relays.



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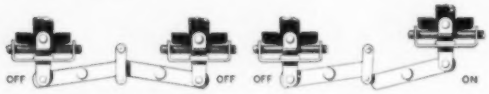
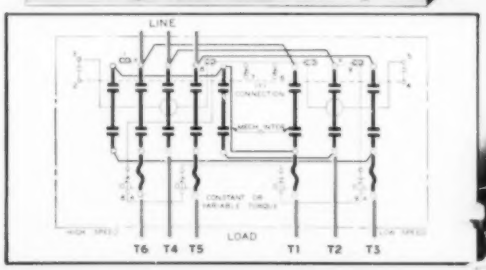


OFF POSITION **ON POSITION**



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tonian liquids, suspensions, and gels. Lecture III, considers the flow of solids under stress, including the effects of temperature. The author also points out why behavior predicted on the basis of a perfect single crystal differs from the actual behavior in a real metal.

Alternating-Current Machinery

BENJAMIN F. BAILEY, *Professor Emeritus of Electrical Engineering, and* JAMES S. GAULT, *Professor of Electrical Engineering, University of Michigan.* 421 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc.,* 330 *W. 42nd St., New York* 18, *N. Y.* $6.

This new college text for use in undergraduate courses in alternating-current machinery includes study of transformers and the principal kinds of synchronous and induction machines, both polyphase and single-phase. In addition to construction and theory of operation of each type, the book covers connections, applications, and methods of control. Several special machines and applications are treated briefly.

Since the book is not intended as a design text, very few design formulas are included. Nevertheless, particularly in the case of motors, certain design features are discussed in connection with their effect upon starting performance and normal operation.

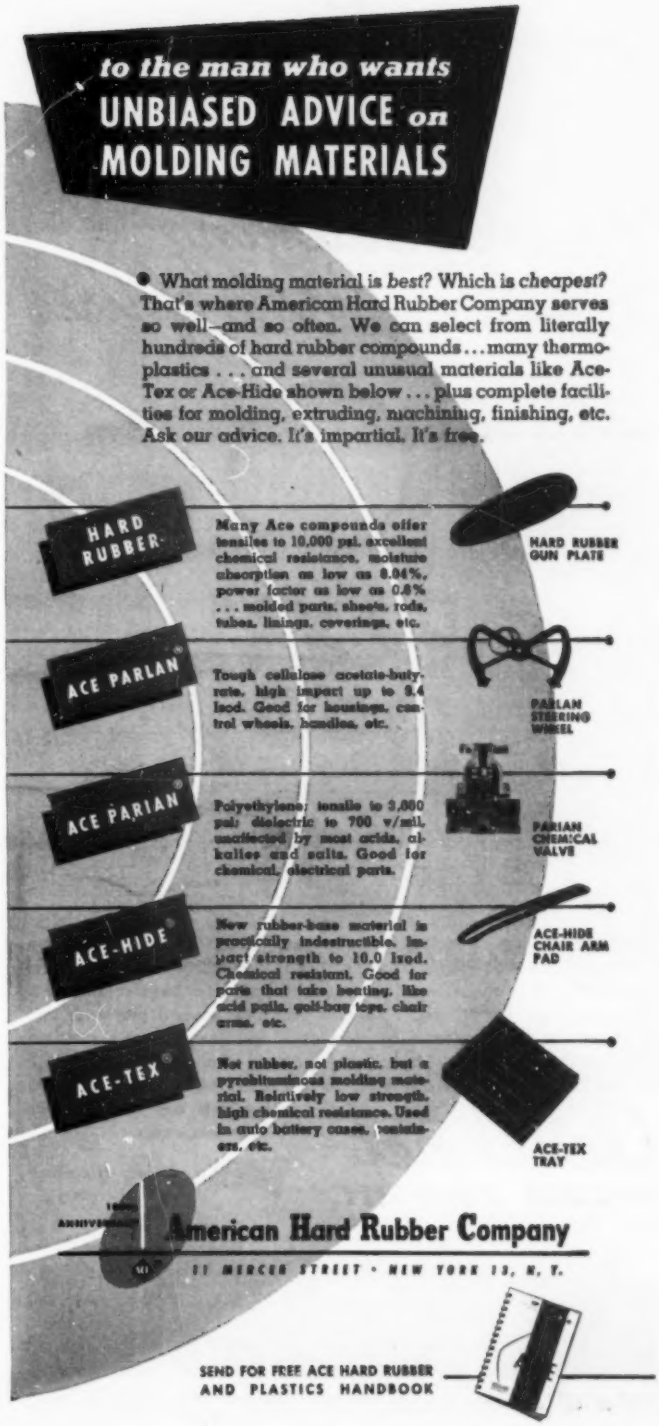
Where it is helpful, the use of mathematics is not avoided, but major emphasis is placed on giving a clear physical picture of machine operation, and developing the student's ability to analyze machine behavior. In order to avoid breaks in the continuity, most of the more involved mathematical developments are deferred to the last three chapters.

The material covered is suited to the needs of all electrical engineering students, regardless of their specialized interests. Some additional material, however, is included for power majors who wish to go further, and to provide a link with subsequent courses in machine design or control and operation.

Dynamic Motion and Time Study

JAMES J. GILLESPIE, MANAGEMENT CONSULTANT. 140 *pages,* 5½ x 8½ *in. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y.* $3.75.

Although the application of motion study in industry has been of considerable value it has, in recent years,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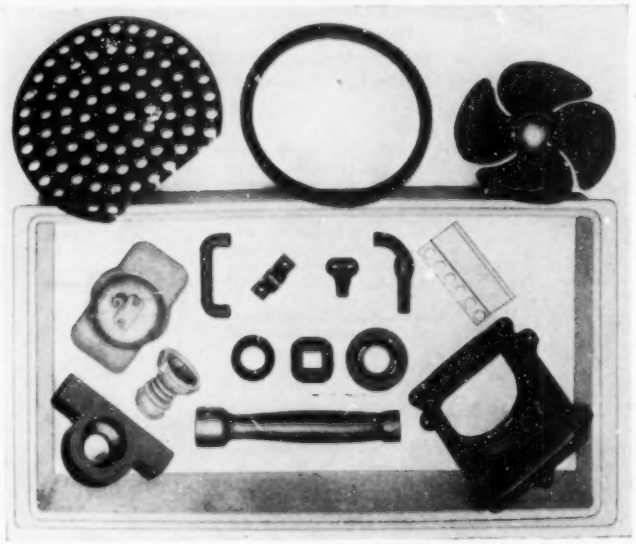

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descended to comic levels. Actually, the art has become micromotionism and, with its motion cameras, therbligs, micromotion clocks, lights on the operator's limbs and its simo charts, it has become a complex, unwieldy technique. Worse still, with its wide acceptance and publication of principles such as that of minimum movements, it has become divorced from practical, humanitarian knowledge; this principle insists that the hapless operator to be tied to finger movement, if that is possible, because these movements are fastest in time.

In this book, work activity is related to work psychology. There are psychologies of nearly everything but work, and that a work psychology is here developed and applied is of significance.

Elementary Problems In Engineering

H. W. LEACH and GEORGE C. BEAKLEY, *Professors of Engineering, Tarleton State College. 269 pages, 6 x 9 in. Published by The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. $3.50.*

This text is written for use in engineering problems courses. All problems and explanations are based on the assumption that most problems courses are offered in the freshman year. Subject matter and problems have been selected with the thought of helping students adapt themselves to college work and also to assist in the transition from high school to the college engineering level. Sections are included on slide rule manipulation, logarithms, elementary trigonometry, motion equations and basic principles of mechanics to parallel and supplement the work in first year college courses in algebra, trigonometry, engineering drawing, chemistry and shop work. Explanations in this book are not assumed to be complete discussions of the subject matter involved, but rather a set of reference notes for student use. The number of drill problems included will meet most normal needs for courses meeting three hours per week for two semesters. Stated problems included are designed to illustrate basic principles of mathematics and physics, and at the same time, to stimulate students' thinking and interest through certain engineering applications. Certain problems have been included, the solutions of which will depend on information to be gained from outside tables or handbooks.

One of the objectives of a problems course is to teach neat, orderly, and

systematic methods of presenting problem solutions. The authors have compiled a workbook of problems to supplement those given in the text. The problems are prepared so that a minimum of layout work needs to be done by the student. This provides more time for practice in slide rule technique and problem analysis. The pages are perforated so they may be turned in as separate assignments. These workbooks may be secured from the authors.

Encyclopedia on Cathode Ray Oscilloscopes and Their Uses

JOHN F. RIDER AND SEYMOUR D. USLAN, 982 *pages*, 8½ x 11 *in. Published by John F. Rider Publisher, Inc.*, 480 *Canal St., New York* 13, *N. Y.* $9.00.

This book presents a cross-section of cathode-ray-oscilloscope theory and applications, which covers most of the fields where this device is used. Concurrently with the increased use of cathode-ray oscilloscopes in radar, television and other electronic fields, rapid advances have been made in the use of the device in non-electronic studies. Such quantities as vibration, pressure, rotary motion and light can be converted into voltage waves that can be displayed and analyzed on the screen of the oscilloscope.

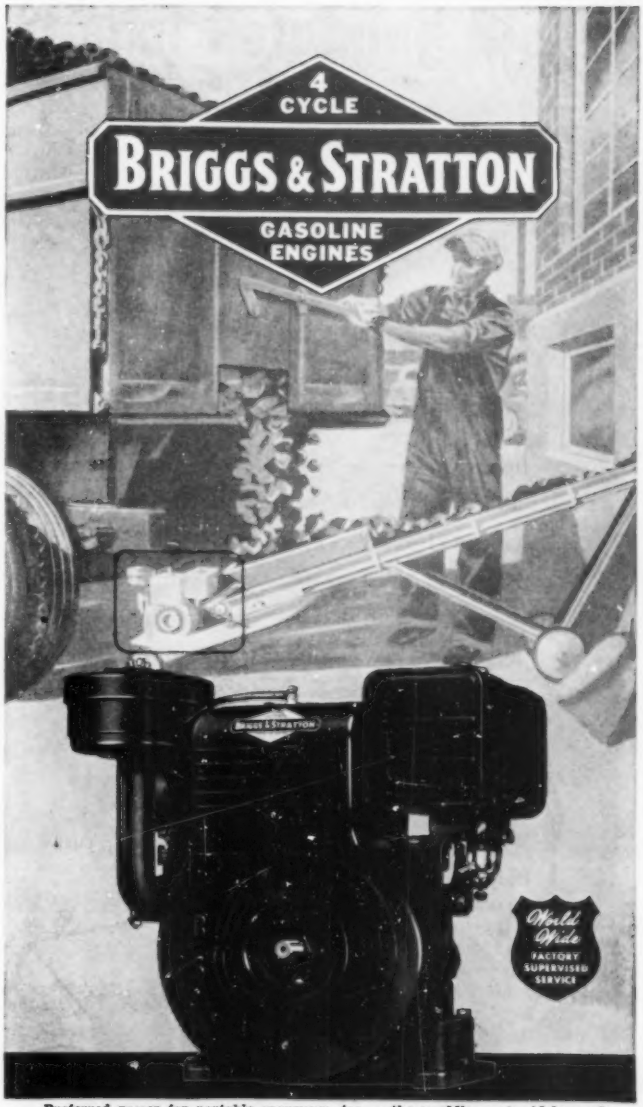
The topics covered include extensive data on the construction and operation of oscilloscopes, then goes on to discuss specific types of applications. Chapters on the latter include: Phase and Frequency Measurements; Test Audio-Frequency Circuits; Waveform Observation in Television Receivers; Electrical Measurements, Scientific and Engineering Applications; and, Complex Waveform Patterns.

The text is written to be understood by the non-electronic engineer. The only assumption made is that the reader has a general background in electricity and magnetism and knows the rudiments of vacuum-tube theory and application.

Engineering Graphics

JOHN T. RULE *and* EARLE F. WATTS, *professor and head of Graphics section, and late associate professor of Graphics section, respectively, Massachusetts Institute of Technology.* 298 *pages*, 6 x 9 *in. Published by McGraw-Hill Book Co.*, 330 *W. 42nd St., New York* 18, *N. Y.* $3.75.

In the preparation of material for this textbook, the authors have been guided by the belief that: "The mod-



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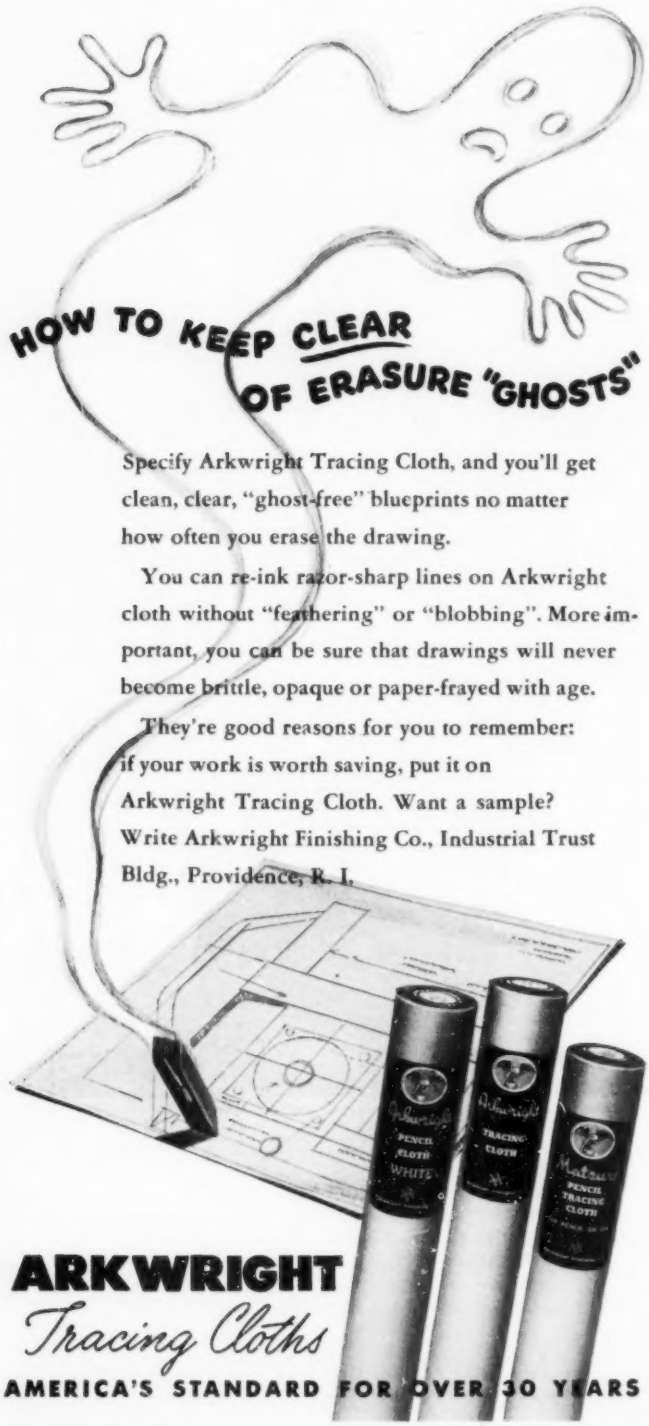
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ern graphics course should develop the basic theories of both the analytical and representational sides of graphics. It should concern itself with the power to understand and use without allowing itself to be dominated by professional details and standard practices which can be easily acquired in special fields. Furthermore, manual skill in the use of drawing equipment can be taught as well; for example, by a problem in graphical integration as by the drawing of a machine part."

In conformity with this philosophy, the authors emphasize underlying theory. The principles of projection, pictorial drawing, dimensioning, and the construction of working drawings are presented through the use of simple examples. Specialized shop practices, knowledge of symbols, threads, fasteners, keyways, and the like are reduced to a minimum, for the reason that this information is readily acquired when the occasion demands. The aim of this part of the text is not to train a practical draftsman in detail, but to give the engineer a usable knowledge of the principles with which the draftsman works.

The text discusses and coordinates the graphical processes that are of value to the engineer. It develops an over-all theory of graphics that shows the reader the capacity of the graphical processes, and aims to give him the ability to appraise the merits of a graphical solution with those of an algebraic solution of any problem he may encounter.

Industrial Piping

CHARLES T. LITTLETON, *Formerly Engineer in Charge of Piping, American Cyanamid Co. Special Chapter on Estimating by R. A. Dickson.* 394 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Company, Inc.,* 330 *W.* 42*nd St., New York* 18, *N. Y.* $8.00.

This is a practical book that brings together in a single volume a store of essential information on industrial piping. It points out what materials and what kind of pipe and fittings should be used, and where. It provides pertinent data on scores of different materials and types of piping required in the chemical, process, and petroleum industries and power plants, to aid in the choice between one material and another.

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used to solve such problems as determining pipe sizes and pressure drops are presented. For each service—water, gas, steam, etc., is furnished material covering methods of flow calculations as well as the material, fittings, and valves used for that specific service. Tables of fittings are grouped according to the services for which they are generally used for convenient reference.

Each of the most recently developed piping materials, alloys, and plastics used in modern industrial plants are discussed, with their advantages and disadvantages indicated. A table of valve equivalents for valves in the pressure classes up to 600 pounds is given. These equivalents give the catalogue numbers of about a dozen leading valve manufacturers.

Electric Circuits For Engineers

EDWARD K. KRAYBILL, *Assistant Professor of Electrical Engineering, Duke University.* 212 *pages,* 6 x 9 *in. Published by The MacMillan Co., 60 Fifth Ave., New York* 11, *N. Y.* $3.85.

The complexity of modern industry and the magnitude of its development have made it imperative that a qualified engineer have considerable knowledge and a high degree of skill in one particular field. Equally important is the requisite that a successful engineer be well acquainted with immediately related branches of engineering and, moreover, have at least a working knowledge of certain fields that may even appear to be quite unrelated.

Few engineers, regardless of their field of specialization, can practice successfully without a certain minimum acquaintance with electricity. Engineers in most fields must know how to make intelligent designs and applications of electric devices. To do so requires an understanding of electric circuits, the fundamental basis to which the analysis of most electric apparatus can be reduced. An ability to analyze circuits is considered an important ingredient in general engineering skill. A background of electric circuit comprehension facilitates further study in other fields of electrical engineering as dictated by necessity or personal interest.

In this book, a broad picture of steady-state electric circuit theory is presented by the logical combination of alternating-current and direct-current relationships into an integrated and unified whole. A working knowledge of elementary differential and integral calculus and physics work equivalent to that given most engineering

students are essential for adequate comprehension of the circuit theory presented.

Certain points of presentation are to be noted. An attempt has been made to correlate electric phenomena with related (and perhaps more familiar) phenomena in the general scientific field. Terminology, definitions and graphical symbols used are those of the American Standards Association as set forth in its publications, *American Standard Definitions of Electrical Terms* and *Coordinated Electrical Graphical Symbols*. Problems based on values representative of those occurring in a variety of actual apparatus have been included to inject certain general engineering information not contained in the text proper. Special effort has been made to achieve lucid presentation through use of diagrams, sketches and supplementary photographs.

An Introduction to Experimental Stress Analysis

GEORGE HAMOR LEE, *Associate Professor at U. S. Naval Postgraduate School*. 6 x 9 *in.*, 319 *pages. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., N. Y.* 16, *N. Y.* $5.50.

The objective of this textbook is to present only the basic aspects of the more commonly encountered methods of experimental stress analysis. A brief introduction to the theory of elasticity is given in the first chapter. Other chapters carry the following titles: Stress Determination from Strain Measurements, Structural Similitude (use of models), Strain Gages, Variable Resistance Wire Strain Gage, Optical Photoelasticity Apparatus, Experimental Photoelasticity Procedure, Analogies, Brittle Lacquer Method and Miscellaneous Methods in Experimental Stress Analysis. A discussion of the evaluation of experimental error and the accuracy of final results is given in the last chapter. Select bibliographies are appended to each chapter; these bibliographies cover rather completely the more advanced techniques and practices of the various methods considered.

A serious effort has been made to use the terminology most commonly found in the literature. Ambiguity has been avoided by using accepted definitions, such as those set down by the American Society for Testing Materials. The notation is that recommended jointly by the American Standards Association and the American Society of Mechanical Engineers.

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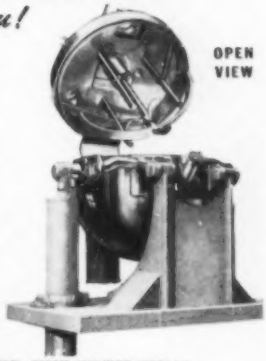

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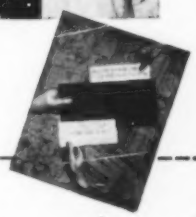

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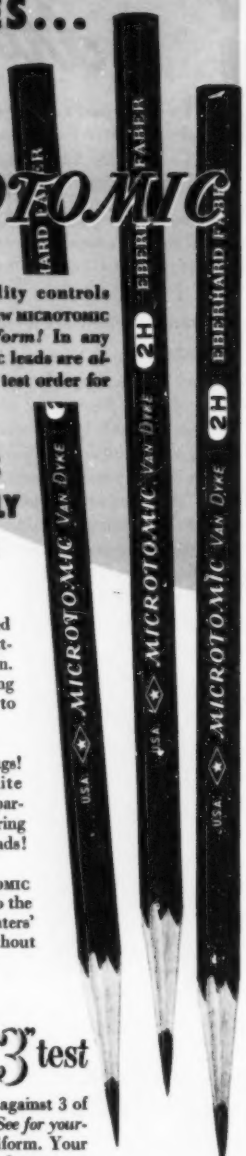

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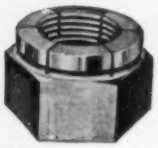


STAY

TIGHT

AFTER

171,360,000

VIBRATIONS AT 4000 CYCLES PER MINUTE...

Plain nuts with lock washers loosened after only ONE HOUR of 4000-cycle-per-minute operation on the vibrator of a concrete block machine at the plant of the Bethayres Concrete Block Co., Bethayres, Pa.

When FLEXLOC Self-Locking Nuts were installed, they were *still tight* when the machine was torn down for rebuilding after 6 weeks operation—at 4000 C.P.M., 17 hours a day, 7 days a week!

If you have an application where nuts loosen or back off, try FLEXLOC, the one-piece, all-metal STOP- and LOCK-NUT "that won't work loose."

Send for Bulletin 619-A today.

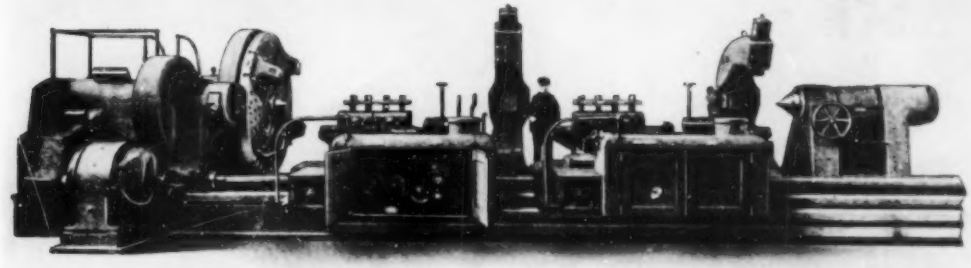
-SPS-

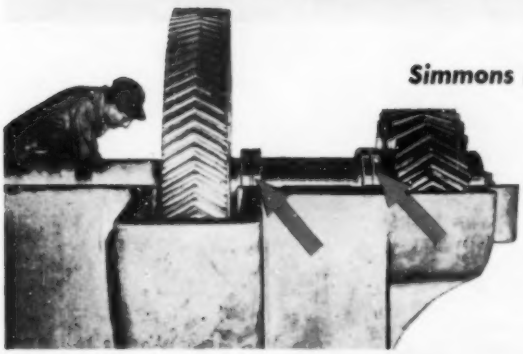
STANDARD PRESSED STEEL CO.

JENKINTOWN 28, PENNSYLVANIA

100" Lathe rebuilt "better than new" by SIMMONS MACHINE TOOL CORPORATION

● True to its slogan "Engineered Machine Tool Rebuilding", Simmons Machine Tool Corp., Albany, N. Y., redesigned and rebuilt this giant 100" Lathe into an exceptionally quiet, smooth-running machine, with 100% increase in spindle speed. Typical engineering improvements made in the headstock, included installation of Orange Cage Type Needle Bearings in place of plain bearings; Sykes herringbone gears instead of spur gears on two final gear reductions; pressure lubrication system to all gears and bearings.





Simmons reports many advantages by using

ORANGE *Cage Type* NEEDLE BEARINGS

● The exclusive Orange cage design holds all rollers in permanent alignment—prevents skewing—permits precision-controlled internal clearances. Orange Cage Type Needle Bearings are especially well-adapted to vertical installations — spindles — overhung mountings—and relatively high speed applications. They are less affected by misaligned mountings and uneven loading. Provide high load capacity in small space—assure quiet, precision running, with long life expectancy. Sizes from ½" to 8" shaft diameters.

THE 11 Orange Cage Type Needle Bearings installed on headstock shafts in place of bronze bushings, are credited by Simmons engineers with at least half of the 100% increase in spindle speed. Equally important, the Orange cage design permits some shaft misalignment between bearings without harm and prevents skewing of rollers due to uneven loading. Simmons rates Orange the most adaptable of all bearings to carry required loads within existing dimensions, when changing over from other type bearings.

WRITE FOR ENGINEERING DATA FOLDER on Orange Cage Type Needle Bearings.

ORANGE ROLLER BEARING CO., INC., 551 Main Street, Orange, N. J.

Laminated INSUROK®

AVAILABLE IN

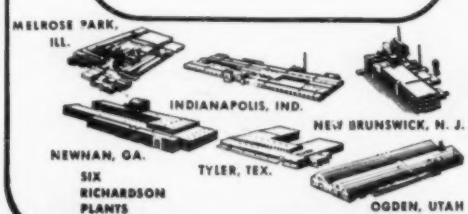
SHEETS

RODS, TUBES

PUNCHINGS

GEAR BLANKS and Fabricated Parts

In Many Grades and Sizes



INSUROK laminated plastics comprise a great family of valuable materials with many diversified uses in the electrical, mechanical, and chemical industries. These precision-made laminates are available in more than fifty grades, including NEMA grades, grades that meet the requirements of military specifications, and *special* grades —a few of which are described on the opposite page. Each special INSUROK laminate has a combination of properties developed by Richardson engineers for superior performance in specific applications. Further information on these special grades, or on any INSUROK laminate, is available without obligation.

A FEW INSUROK GRADES FOR SPECIALIZED PURPOSES

ELECTRICAL GRADES (1/16" Thickness)

GRADE	DESCRIPTION	Moisture Absorption (24 hrs.)	Power Factor	Dielectric Strength (v/mil) Short Time	Dielectric Strength (v/mil) Step by Step	Insulation Resistance (Megohms)	Loss Factor at 1 MC	Dielectric Constant
T-805	A paper base NEMA PC laminate, for cold-punched electrical and mechanical parts involving nominal voltage-frequency-humidity relationships.	4.0%	0.060	550	425	400	0.30	5.0
T-838	A paper base laminate, suitable for many electrical applications. Meets requirements for NEMA Grade XX. Has good machinability.	1.3%	0.040	700	500	2,000	0.20	5.0
T-640	A paper base laminate, for electrical and mechanical uses. Possesses low moisture absorption, excellent mechanical strength and machinability.	0.67%	0.0312	675	590	30,000	0.147	4.70
T-725	A paper base laminate, for superior high-frequency electronic insulation. Maximum stability under varying humidity. Hot-punches into intricate shapes.	0.42%	0.030	700	600	121,000	0.134	4.46
T-606	A fabric base laminate, meeting NEMA Grade CE requirements. For electrical applications requiring greater moisture resistance than Grade C provides.	2.2%	0.055	360	280	100	0.28	5.0
T-712	A continuous-filament Fiberglas laminate, bonded with melamine resin. Its high arc resistance is valuable in many electrical applications.	1.6%	0.013	475	375	25,000	0.08	6.4

MECHANICAL GRADES (⅛" Thickness)

GRADE	DESCRIPTION	Tensil Strength (psi) Main Direction	Tensil Strength (psi) Cross Direction	Flexural Strength (psi) Main Direction	Compressive Strength (psi) Flatwise	Impact Strength Main Direction (Ft Lb/In.) Flatwise	Impact Strength Main Direction (Ft Lb/In.) Edgewise	Moisture Absorption (24 hrs.)
T-689	A fine-weave fabric base laminate especially suited for intricate parts requiring great strength, such as fine-pitch gears. Good dimensional stability.	18,000	11,200	29,000	42,000	----	----	0.5%
T-733	A linen base NEMA Grade L laminate, for mechanical and electrical parts requiring fine machining, dimensional stability, and physical strength.	14,000	9,500	22,000	38,000	4.6	2.3	0.7%
T-815	A cotton-fiber, mat base laminate, featuring uniform strength in all directions in the plane of the sheet surface. For smooth, high-strength, machined parts.	15,000	15,000	22,000	45,000	3.0	1.4	0.7%
T-601	A strong, tough, fabric base laminate, suitable for gears and other mechanical parts subject to high impact loads. Meets requirements for NEMA Grade C.	11,000	11,000	21,000	40,000	4.2	2.5	0.9%
T-682	A fabric base laminate, designed for valve discs, pump valves, agitator paddles, etc., handling hot or cold water, gasoline, oil, and some mild acids.	10,700	9,700	19,800	37,400	4.2	2.5	0.8%
T-602	A canvas base laminate, with a high natural graphite content. Especially suitable for bearings and other parts subject to friction.	8,000	7,000	16,500	35,000	2.6	1.8	0.5%

The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

2793 Lake St., Melrose Park, Illinois (Chicago District)

SALES OFFICES: Cleveland • Detroit • Indianapolis • Lockland, Ohio • Los Angeles Milwaukee • New Brunswick, (N. J.) • New York • Philadelphia • Rochester • St. Louis

Write for 20-Page Booklet "Laminated Plastics" or a Data Sheet on Any Specific Grade

Again the time has come 1943
to ask your company,
and every company, to
Get in the 1951
SCRAP

FOR every ton of ingot steel produced, at least a half-ton of iron and steel scrap must have *previously* reached the furnaces. Steel is currently being produced at full capacity, more than 100 million ingot tons annually—and there is a developing scrap shortage of serious proportions. Just as in the early years of World War II, the steel industry asks the help of *all* industry to relieve the situation.

TWO IMPORTANT THINGS TO DO

(1) CLEAN OUT YOUR PLANT SCRAP. This is a job that every company can do. Old, worn-out or out-moded and replaced machinery and equipment, rails, structural parts, etc. constitute the "heavy melting scrap" which the steel industry needs most. Clean up *your* plant and yards—move out this heavy scrap into the channels of use.

(2) HURRY BACK YOUR WORKING SCRAP. Don't let the waste of metal-working—turnings, borings, punchings, crop ends, etc.—lie around the plant a day longer than necessary. Keep it moving, back to the furnaces. And doubly important, *be sure to classify and segregate your alloy steel scrap.* Thus handled, it not only commands a higher price, but will help to conserve the nation's supply of critical alloys, practically all of which are highly essential.

Contributed in the National Interest by

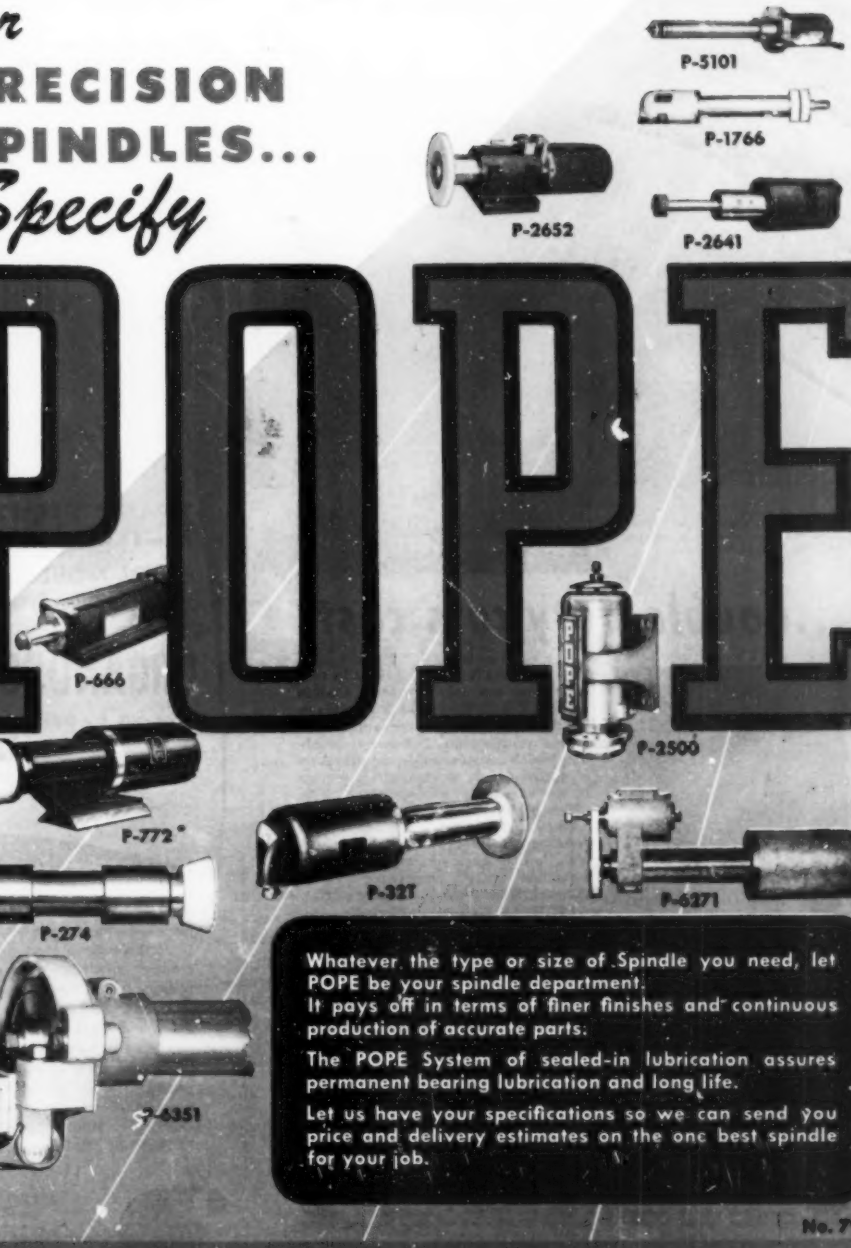
ALLEGHENY LUDLUM STEEL CORPORATION

Henry W. Oliver Building • Pittsburgh 22, Penna.

W & O CL 8019

For
PRECISION SPINDLES...
Specify

POPE



Whatever the type or size of Spindle you need, let POPE be your spindle department.
It pays off in terms of finer finishes and continuous production of accurate parts.

The POPE System of sealed-in lubrication assures permanent bearing lubrication and long life.

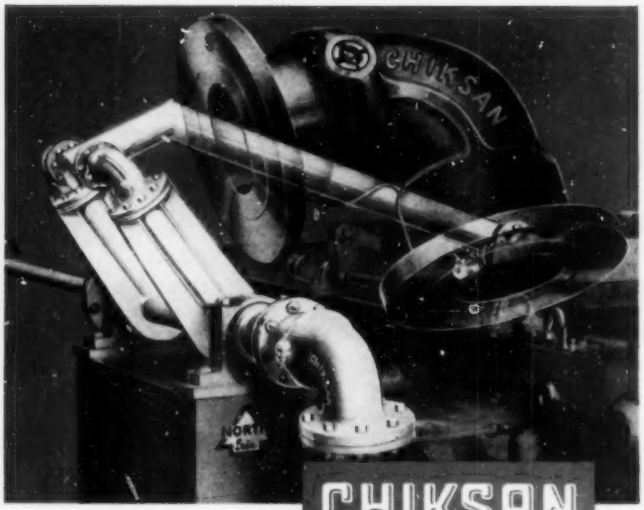
Let us have your specifications so we can send you price and delivery estimates on the one best spindle for your job.

No. 79

POPE

TRADE MARK REG. U.S. PAT. OFF.

POPE MACHINERY CORPORATION
ESTABLISHED 1920
281 RIVER STREET • HAVERHILL, MASSACHUSETTS
BUILDERS OF PRECISION SPINDLES



The vacuum-operated transfer mechanism on this linoleum press picks up the sheets and stacks them on a conveyor, ready for the next operation.

CHIKSAN
Ball-Bearing Swivel Joints

...double-duty cuts costs

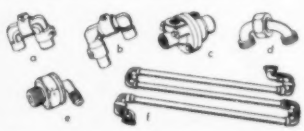
The vacuum line, with CHIKSAN Swivel Joints for flexibility, also serves as the lever arm to operate the transfer plate.

The frequency of operation is approximately 18 strokes per minute through an 80° arc, under 24" vacuum.

The CHIKSAN Swivel Joints in this application not only provide a flexible vacuum line... they make it possible to use the line itself as a lever arm to operate the transfer plate. This means double duty which makes possible simplification of design which, in turn effects savings in manufacturing and operating costs.

Wherever a flexible line can also be used as a mechanism, CHIKSAN Swivel Joints provide for precision movement with low torque, ample strength and maximum safety... under pressure or vacuum. Sizes from ⅛" through 12".

CHIKSAN Engineers will gladly cooperate with you in selecting the correct Swivel Joints for your particular application. Write for Catalog No. 50-AH.



(a) Basic Type Swivel Joints – for pressures from 125 psi. to 15,000 psi. (b) High Temperature Swivel Joints for temperatures to 500° F., working pressures to 700 psi. (c) Rotating Joints for 150-lb. steam, brine, etc. For hot and cold rolls, tumblers, platens, etc. (d) Sanitary Swivel Joints for food processing, fruit juices, dairies, etc. (e) Hydraulic Swivel Joints for pressures to 3,000 psi. For aircraft, industrial and armored equipment. (f) Flexible Lines, designed and fabricated to meet specific requirements.

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WELL EQUIPMENT MFG. CORP., HOUSTON 1, TEXAS

BALL-BEARING SWIVEL JOINTS FOR ALL PURPOSES

FOR PRODUCTS WAITING TO BE MADE...

Stanley
PLASTISOLS
FOR MOULDING OR COATING
ORGANOSOLS
FOR FABRIC OR PAPER COATING
FOR DIPPING

For national defense today Stanley Plastisols and Organosols can be formulated to meet rigid government specifications, with emphasis on low temperature flexibility and fungus resistance.

For competitive selling tomorrow they'll mean greater durability and sales appeal for your product. Write today; take advantage of our years of vinyl experience: Stanley Chemical Co., 71 Berlin St., E. Berlin, Conn.

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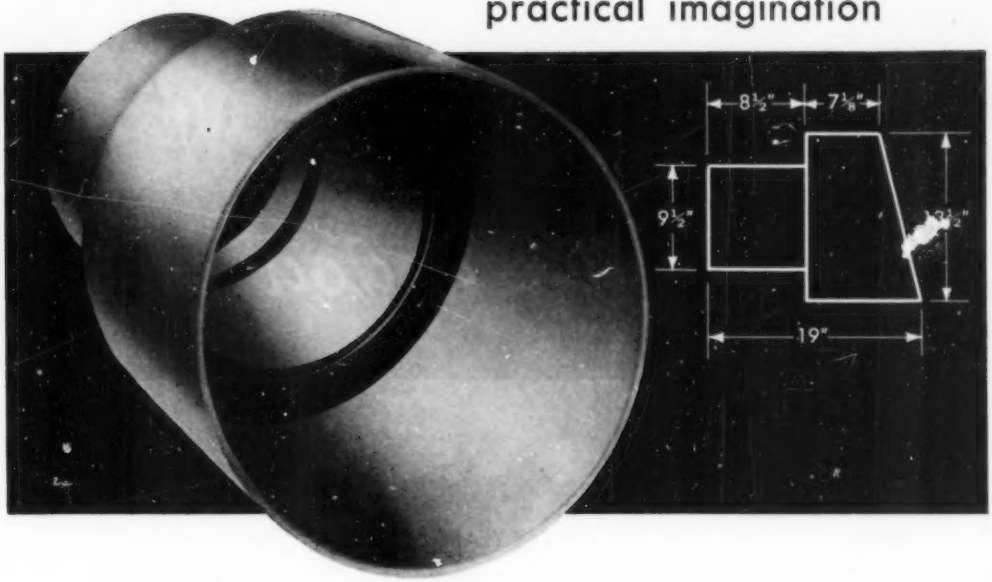
practical imagination



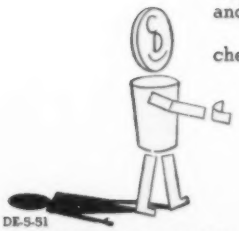
"welded" assembly makes large plastic parts practical and economical

Look at this large, laminated plastic part. It is 19" long with two concentric diameters of 13½" and 9½" connected by a flat ring. Think of the cost of molds for making such a piece—and then consider the fact that only a few such parts are required. The cost would be prohibitive.

It is on problems like this that Continental-Diamond's knowledge of plastics and their fabrication pays off for you. C-D engineers took two Dilecto tubes of the required diameters and wall thicknesses and then cut a ring from a sheet of Dilecto to just fit the O.D. of the smaller tube and the I.D. of the larger.

These three parts were then literally "welded" together into a strong, low cost part. The material used to do the "welding" is one of the compounds developed by C-D in their vast experience of fabricating parts of Fibre, Vulcoid, Celoron, Micabond, Dilecto and combinations of all of them.

If you have a problem—or a standard application for plastics, it will pay you to check with your nearest C-D office.



your partner in producing better products

DILECTO (Laminated Thermosetting Plastic)
CELORON (Molded High-Strength Plastic)
DIAMOND FIBRE (Vulcanized Fibre)
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Established 1895. . Manufacturers of Laminated Plastics since 1911—NEWARK 40 • DELAWARE

No Problem's

when you call

Better
DIE CASTING
in
ALUMINUM
MAGNESIUM
AND ZINC

FIFTY YEARS of better die casting has taught Precision what you need to know to IMPROVE QUALITY . . . REDUCE COST . . . STEP UP PRODUCTION . . . and INCREASE PROFITS.

Through a great half century of fast-paced industrial progress, Precision know-how, ingenuity and determination have contributed a lion's share of improved production methods.

Today when production methods must change almost over night to meet and beat competition, Precision can be of real service to you.

CUT COST AND IMPROVE PRODUCT APPEARANCE

Pictured at right is an example of one of the ways in which Precision has pioneered in the die casting industry. The die maker is holding a die that was made 2½ years ago for casting a spur gear. Contrast it with the four and one-half ton modern-day die for casting a complete automotive grille for one of today's cars.

PRECISION CASTINGS CO., Inc.
212 Walnut St., Fayetteville, N. Y.
Syracuse, N. Y. · Cleveland, O. · Kalamazoo, Mich. · Chicago, Ill.
British Affiliation — Wolverhampton Die Casting Co., Wolverhampton, England

Call a **PRECISION** *Engineer Today*

too Tough *in* PRECISION!

. . . put your problem to **PRECISION** *and get the answer!*

HERE'S WHY

no other coupling costs as little to use as *FAST'S*

With Fast's Couplings you get the lowest coupling cost per year that modern engineering can provide—*because Fast's normally outlast the equipment they connect.* That means their cost can be spread out over 20 years or more!

As two users recently said:

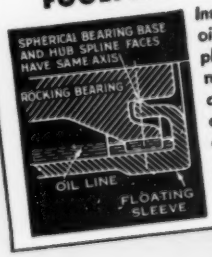
"We've had this Fast's Coupling since 1930 . . . and it's apparently going to last forever. [Wish] the other equipment caused as little trouble!" . . . "We have two Fast's Couplings . . . they are the only equipment so trouble-free we long ago forgot we had them!"

If you want lower costs, freedom from coupling shutdowns and dependable coupling engineering—specify Fast's. For complete details, mail the coupon for Fast's free catalog. Do it today!

RUGGED CONSTRUCTION:

Fast's still maintains its original design, without basic change or sacrifice in size or material. This assures you freedom from needless and expensive coupling failures.

FOOLPROOF DESIGN:



Instead of perishable oil seals, Fast's Couplings use a permanent metal-to-metal closure to keep dust out and oil in. Oil is always maintained at a safe level whether the Fast's is running or standing still.

FREE SERVICE:

When you specify Fast's Couplings you get Koppers' valuable free coupling service. If your application seems to need a special coupling, Koppers' engineers in many cases can easily modify a standard Fast's Coupling, and save you money!

MAIL COUPON TODAY FOR FREE CATALOG!

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Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

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Company.....

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FAST'S

THE ORIGINAL GEAR-TYPE

Couplings

INDUSTRY'S STANDARD FOR 31 YEARS

STANDARDIZE WITH OHIO

OIL SHOULD BE NON-CORROSIVE — NON-FOAMING — NON-OXIDIZING
CHECK THE OIL FOR EXCESSIVE HEATING
NEW REDUCERS RUN "HOT" DURING BREAKING IN PROCESS
FLUSH OUT SEDIMENT AFTER FIRST TWO OR THREE WEEKS
CHECK FOR THE PROPER GRADE OF OIL

Ohio Speed Reducers, correctly installed and lubricated require practically no attention. There is no constant supervision and adjusting. The housing interior of Ohio Speed Reducers is so designed to direct proper lubrication back to the bearing. Only an occasional replacement of lubricating oil is necessary. It is generally agreed among power transmission authorities that the most satisfactory lubrication of speed reducers is obtained through the use of high grade petroleum oils; as temperatures sometime become extremely high, the oils should retain their body and lubricating qualities under heat. If the unit is operated in extremely low temperatures, the oil should have a pour test lower than the lowest surrounding temperature.

Ohio Speed Reducers are filled at the factory with the proper oil to the correct level. After a few weeks of operation, the unit should be drained and flushed and old oil should be replaced or filtered to free solid particles caused by wearing in process. Oil should be changed every six or eight months under normal operating conditions, to prevent accumulation of sludge.

Do not have too much oil in housing; violent agitation of the viscous oil generates considerable heat, tending to destroy the lubricating qualities of the oil. If the reducer shows signs of excessive heating, check the oil level which should be neither too high nor too low.

Of the oils found satisfactory for Ohio Speed Reducer operation, the following have wide distribution and are generally available:

Socony Vacuum Oil Co. — Gargoyle Cylinder Oil #600W; The Texas Co. — Pinnacle Cylinder Oil; Cities Service Oil Co. — Optinus No. 6; For low temperatures—Socony Vacuum CW Oil.

Housing should be filled to oil level plug only. Check breather hole, filter hole, drain plug and level plug.

ESTABLISHED 1915

THE OHIO GEAR COMPANY

1325 EAST 179 ST. • CLEVELAND 10, OHIO

OHIO GEARS

Unusually Large Cap Screws—

(usually hard to find)

are regular

CLEVELAND

Top Quality

production

For many years Cleveland has catalogued "larger than usually listed" sizes of hex head Cap Screws—stocks a fair assortment whenever possible—makes for you whatever you need up to 2½" diameter, lengths to 36". Also Set Screws to 1½" x 10". Clean, well-made screws, bright or heat treated. Write for sizes and prices.

THE CLEVELAND CAP SCREW CO.

2917 East 79th Street, Cleveland 4, Ohio

Cleveland's standard line includes hex, flat, socket and fillister head Cap Screws; Milled Studs and Set Screws.

Warehouses: Chicago, Philadelphia, New York, Providence

CLEVELAND *Top Quality* **FASTENERS**

Ask your jobber for Cleveland Fasteners

Superb CASTELL *Prints*

NO LONGER A LUXURY

CASTELL DRAWING PENCIL 9000

CASTELL LOCKTITE REFILL HOLDER 9490

Famous CASTELL Drawing Pencil with Imported Lead now available to you at practically no extra cost

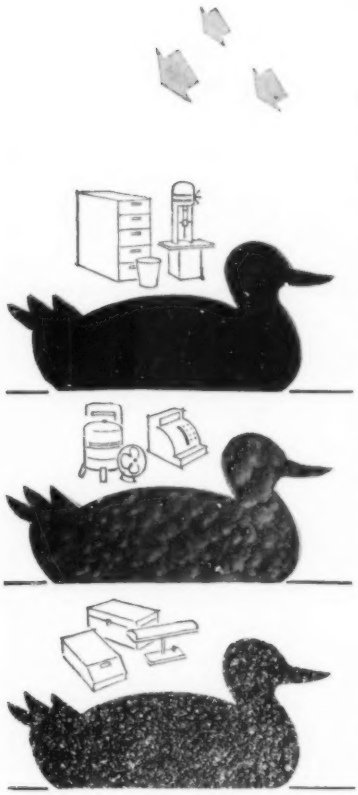
"Industry demands legible prints—and the making of legible prints begins on the drawing board," states Mr. E. S. Fairley, of the well-known B. K. Elliott Company, Pittsburgh, Cleveland, Detroit.

We agree with him 100%. Imported CASTELL Lead *always* has produced more sharp copies per original drawing than any other pencil on the market. New price ranges now bring CASTELL with imported lead within reach of craftsmen who heretofore used ordinary drawing pencils. You, too, may now enjoy the use of the world's finest drawing pencil at no extra cost. See your Dealer today.

A.W. FABER-CASTELL PENCIL COMPANY INC. NEWARK N.J.

SPRUCE UP

"UGLY DUCKLING" PRODUCTS WITH ONE OF THESE THREE S·W "GLAMOUR FINISHES"!



Don't let "hard-to-dress-up" surfaces limit your product's usefulness or sales appeal! One or more of these unique and practical Sherwin-Williams special finishes can give it glamour . . . richness . . . added sales appeal . . . can be adapted easily to your finishing line requirements. Ask for full details on the finishes best adapted to your needs! The Sherwin-Williams Co., General Industrial Division, Cleveland 1, Ohio.

1. DIMENSO "HAMMERED" FINISHES

This exclusive S-W finish is a multichromatic organic that can be applied to any metal or wood surface with a special gun that sprays two colors in a single operation. *Dimenso* bakes quickly to a tough, smooth, durable film of exceptional brilliance. It imparts deep, lasting color, full of life and sparkle and with infinite shadings of tone. It gives realistic, 3-dimensional hammered and spot effects in toned or diffused patterns.

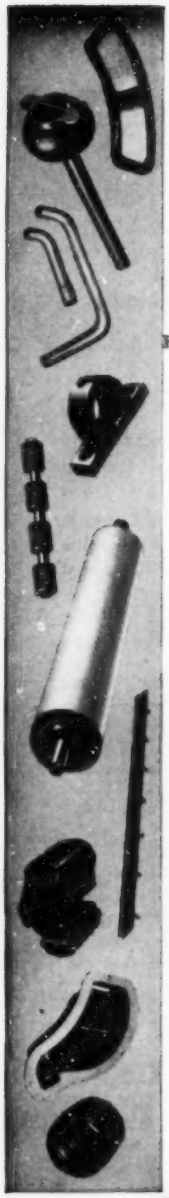
2. DIMENSO ONE-COAT METALLIC

Dimenso One-Coat Metallic offers a high-quality hammered finish at moderate cost with standard spray equipment and a single material. It produces a striking, deep-toned hammer pattern and air dries or bakes to a tough, durable film. By a slight change in method, it is possible to produce an opalescent finish in addition to the hammer finish with identical film characteristics. Available in Silver, Blue, Green and Tan.

3. KEM ART METAL

With this line of durable and distinctive nonmetallic wrinkle finishes, highly decorative effects are possible on a wide variety of products. These finishes are applied with conventional spray equipment and fit into any baking schedules, including extremely fast infrared. The film looks thick and tough—actually is—but, at the same time, it has a velvety appearance which is appealing and restful.

SHERWIN-WILLIAMS
INDUSTRIAL FINISHES



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YOUR INDUSTRY
is on this list—

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you can benefit from

Tyer

Skill, Imagination & Service

Tyer technical knowledge and original thinking are available to you to make Rubber, *our* product, more useful to you in *your* product. The same know-how and resourcefulness that led Tyer to originate White Rubber and Elastic Webbing in the early days of the industry, have enabled Tyer, through war and peace, to supply American manufacturers with

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Tyer
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159 Duane St., **NEW YORK** 189 W. Madison St., **CHICAGO**
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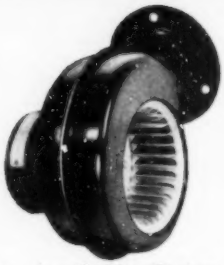
HEINZE
SUB-FRACTIONAL HORSE POWER MOTORS

ZSS



The Most Compact 50 CFM Blowers Available Today.

The Heinze sturdy, low speed type "Z" shaded pole induction motor provides quiet, trouble-free operation.

ZRS

A 3⅝" balanced air rotor, with slow speed, minimizes air noises.

Operating speed, 1650 RPM (free air) Draws 40 watts on 115v, 60 cycles (230 volts supplied if desired)

Can be equipped with L type or Flat Strap brackets in place of flange outlet normally furnished.

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The MIRA never needs to be pointed, yet it draws continuously a line of constant width. How? A unique flat lead .012 inch thick.

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  Cannot be broken
  superior quality—
  available in:
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- No graphite dust
- Choice of 0.30mm or 0.45mm line width
- Prices: { Mira Pencil $3.50
  { Leads (per box) ..... .25

EVENLINE PRODUCTS
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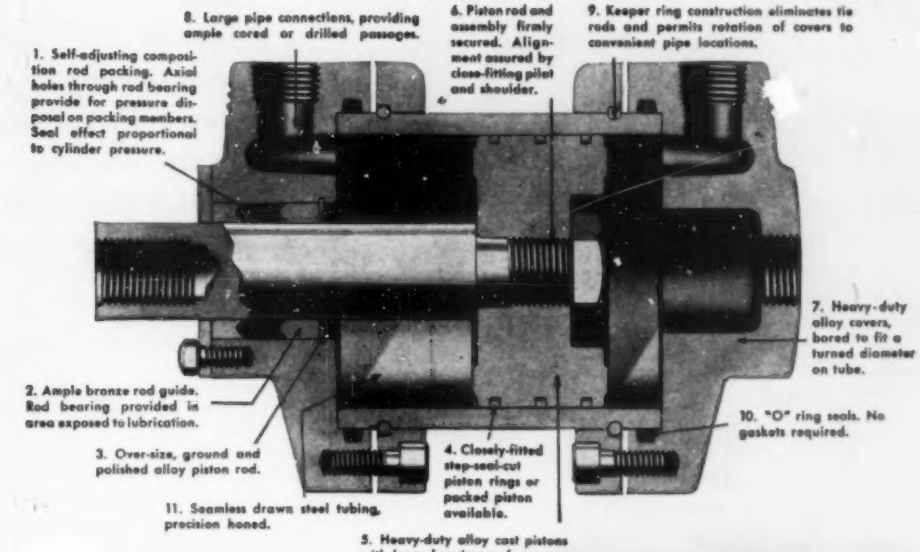
More Power to You


8. Large pipe connections, providing ample cored or drilled passages.
6. Piston rod and assembly firmly secured. Alignment assured by close-fitting pilot and shoulder.
9. Keeper ring construction eliminates tie rods and permits rotation of covers to convenient pipe locations.
1. Self-adjusting composition rod packing. Axial holes through rod bearing provide for pressure disposal on packing members. Seal effect proportional to cylinder pressure.
7. Heavy-duty alloy covers, bored to fit a turned diameter on tube.
2. Ample bronze rod guide. Rod bearing provided in area exposed to lubrication.
10. "O" ring seals. No gaskets required.
3. Over-size, ground and polished alloy piston rod.
4. Closely-fitted step-seal-cut piston rings or packed piston available.
11. Seamless drawn steel tubing, precision honed.
5. Heavy-duty alloy cast pistons with large bearing surfaces.

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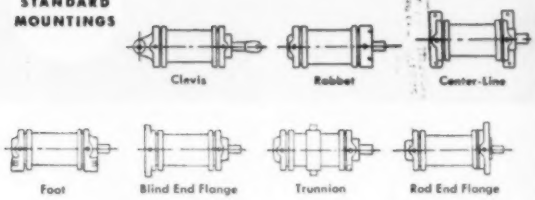

..with RIVETT HYDRAULIC CYLINDERS

You'll find the performance of Rivett hydraulic cylinders close to foolproof. Designed with the utmost simplicity, they have no tie rods — keeper ring design permits covers to be rotated to convenient pipe connections and installation made in a minimum of space. External "O" rings are used as static seals to eliminate gaskets and assure leakproof operation. Sealing efficiency improves with increased pressure. Closely fitted automotive type piston rings reduce friction to a minimum.

Available in three pressure ranges: to 500 P.S.I. maximum and 1500 P.S.I. maximum service with standard models. 3000 P.S.I. maximum and higher services furnished on application. Seven standard mountings, in 10 bore diameters, in any stroke up to 96", with standard size or 2:1 over-size piston rods, cushioned rod end, blind end or both. Special covers supplied. Send for Catalog Section 104.

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RIVETT furnishes a complete power package

VALVES • CYLINDERS • POWER UNITS
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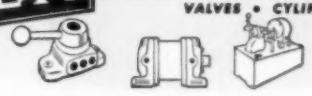

Speed Reducer Selection *Made Easy!*

When speed reduction requirements are within the fractional through 85 hp range, there is no selection problem for the design, consulting or plant engineer.

He *knows* that Winsmith can meet his specifications *precisely* with the world's most complete line within this category. And even more important, he *knows* that recommendations from Winsmith's engineering representatives can always be counted on to be practical and unbiased. That's only natural with so large a variety of standard units to choose from.

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Fully descriptive literature, which includes suggestions for simplifying and expediting selection, will be mailed at your request.

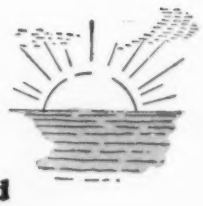
WINSMITH SPEED REDUCERS

MEMBER OF AGMA

WINSMITH, Inc.

111 Maine St., Springville (Erie County) N. Y.

The sun comes up . . .

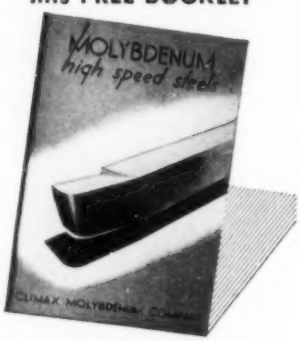


and just as inevitably you will switch to the use of MOLYBDENUM High Speed Steel

It is readily available from manufacturers and warehouses. Tools made from it give service as good as or even better than the tungsten type of steel—most of the high speed steel used by leading tool manufacturers is the Molybdenum type.

You can save money by changing, and above all, you will help to conserve tungsten for uses for which it is really needed.

The facts you need are in this FREE BOOKLET



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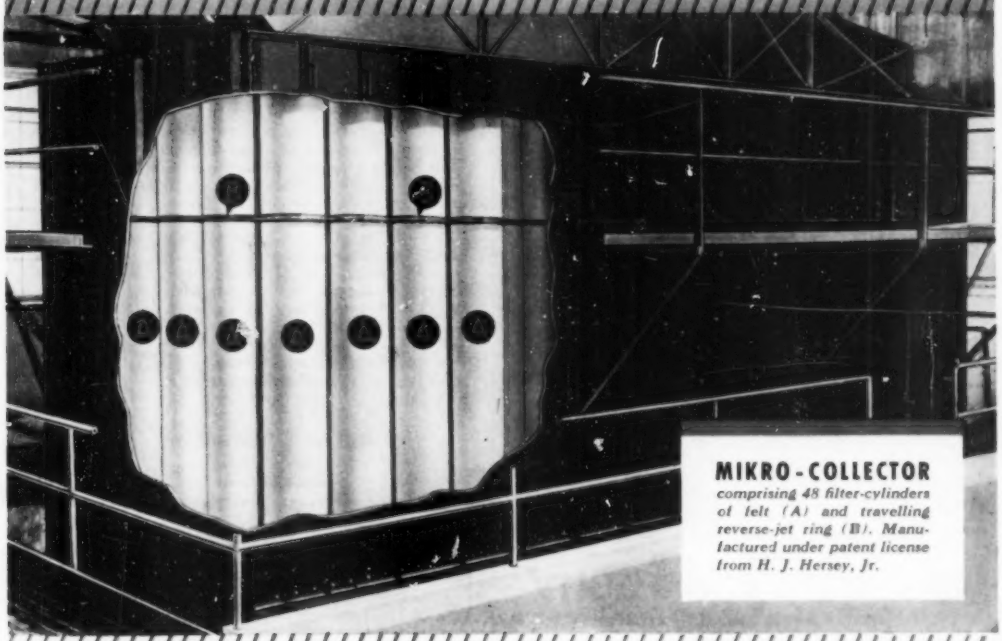
PE 10 HS-10

Optimum dust collection . . .



MIKRO-COLLECTOR
comprising 48 filter-cylinders of felt (A) and travelling reverse-jet ring (B). Manufactured under patent license from H. J. Hersey, Jr.

with AMERICAN Felt

The unique principles employed in the MIKRO-COLLECTOR enable dust recovery (up to 99.999%) and phenomenal filter rates. Pulverizing Machinery Company, Summit, New Jersey, the manufacturer, states that American Felt's wool felt has been found to be a superior filter medium, permitting the easy handling of damp or dry, light or heavy dust-loaded air streams. With the Hersey travelling reverse-jet principle uniform filter resistance is maintained, thus assuring uniform air flow. Used in the handling and recovery of a wide range of dusts and powders, the MIKRO-COLLECTOR serves to eliminate atmospheric pollution, as well as providing full recovery of a valuable product. Dangerous or noxious dusts and minute size dust particles are easily handled. Installations for the handling of ultra-fine radioactive dusts during the past year have a combined capacity of more than 100,000 cfm. The MIKRO-COLLECTOR is manufactured with single and multiple filter cylinders of varying diameters and lengths to meet every requirement.

American Felt Company
TRADE MARK

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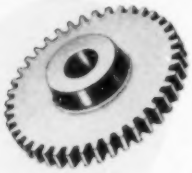

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POWDERED METAL PRODUCTS CORPORATION *of America*

9335 West Belmont Avenue, Franklin Park, Illinois

PMP

*Trade Mark

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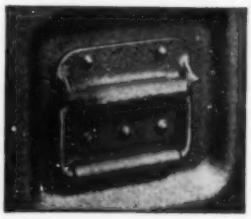

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Here is the handle you have been looking for—one that is ideally suited for anything that must be lifted by a side carrying handle. Because we could not buy anywhere a satisfactory handle for the thousands of cases manufactured by Bendix and needing such an item, Bendix-Friez engineers developed this handle to meet Air Force and other Government specifications for many kinds of special equipment. The unique, rugged design of this handle, with its "snap-back" feature, is such that neither shock nor vibration will cause it to rattle. Built of aluminum and stainless steel, it can be riveted or welded to the side surfaces of any kind of container or depressed in the sides. Available in large or small lots, orders filled promptly. Write for prices.

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MAKES THE TOUGHEST TUBING FABRICATION POSSIBLE

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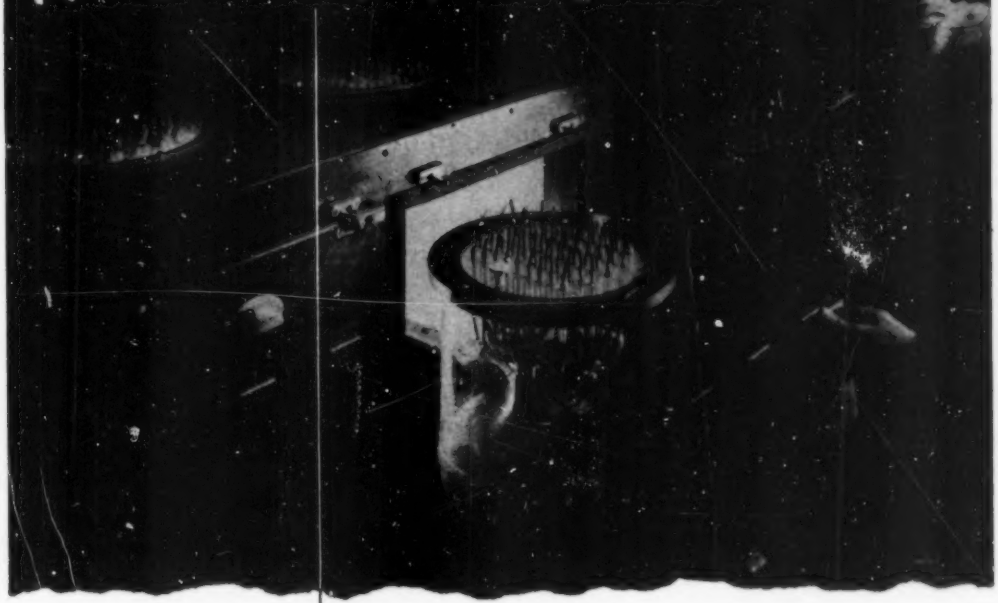

...OF TAYLOR FULL-LINE SERVICE

Set up within the Company is the Taylor laboratory, whose primary responsibility is to develop new Taylor products which will meet industry's ever-increasing demands for laminated plastics with higher insulating qualities.

And, keeping pace with this search for new materials, the Taylor laboratory continually tests Taylor Vulcanized Fibre, Phenol Fibre, and Glass Melamine and Silicone Laminates to maintain the high quality of these versatile materials.

Engineers, working with modern, scientific equipment, constantly check and test each Taylor product until it breaks down and admits the facts.

A Taylor product that cannot survive the third-degree of our laboratory, we feel, is unfit to carry the Taylor name into your plant. The buyer confidence we enjoy is the foundation upon which Taylor has built its reputation for the best in laminated plastics.

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WEST COAST FACTORY: LA VERNE, CALIF.

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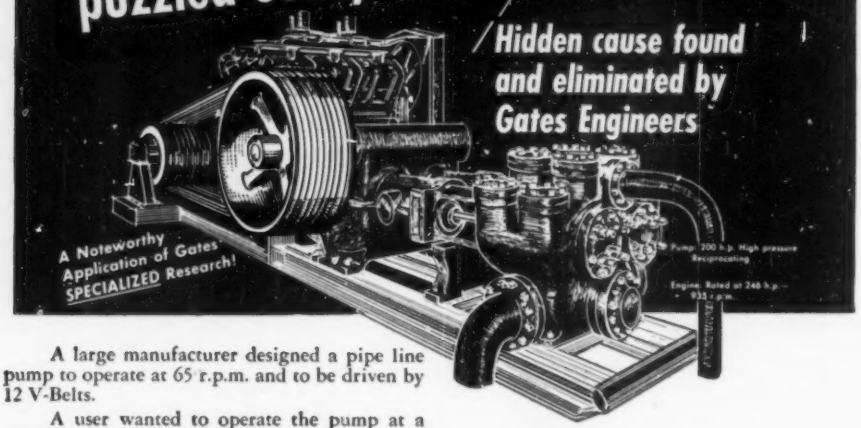
The complete Taylor full-line story is contained in this Taylor 62-page catalog. It contains specifications and description of all Taylor Laminated Plastics. Read how you can make your product or part better with the use of these plus-value materials. Write today for Catalog PE-10.

Severe vibration on pump drive puzzled everyone . . .

Hidden cause found and eliminated by Gates Engineers


A Noteworthy Application of Gates SPECIALIZED Research!
Pump: 200 h.p. High pressure Reciprocating
Engine: Rated at 248 h.p. — 935 r.p.m.

A large manufacturer designed a pipe line pump to operate at 65 r.p.m. and to be driven by 12 V-Belts.

A user wanted to operate the pump at a speed of 90 r.p.m. and realized that additional horsepower would be required. Upon checking the V-Belt drive, it was found that the additional belts required would increase the face width of the sheave and therefore the moment arm of the bearing load. Any increase in bearing load combined with the increased speed was distinctly undesirable and therefore the user sought some means of reducing the overhung weight and width of the sheave.

Learning that a *special* V-Belt had a sufficiently higher horsepower rating to gain the greater pump speed with *only 9 belts*, he had the drive re-designed to use these belts.

When installed on the job, the belts vibrated severely. At a speed somewhat below the desired range, the belts would fly completely off the sheaves. Operation was so rough that it was almost impossible to run the pump at all.

Gates Engineers were called in for consultation. Their analysis indicated that the particular belts used formed a *too-compliant* link between the pump and the engine. This allowed tortional vibration to build up to excess. Therefore, belts of *less compliance* would have to be used.

Accordingly, Gates Engineers wrote specifications for belts having the necessary h.p. rating but with the exact *degree of compliance* that would avert the vibration. These special V-Belts were built by Gates—installed—and the drive operates smoothly under all loads and at all speeds within the range.

The excessive vibration is gone. The clutch operates smoothly at any speed. And 13 additional pumps have since been equipped with identical belts—all operating most satisfactorily.

Gates ability to analyze and correct obscure drive difficulties is no accident—for Gates operates the largest V-Belt Testing Laboratories in the world. And Laboratory findings are carefully checked by tests made under actual field conditions. Finally, the *results* of these exhaustive tests are immediately reduced to *usable data* for the design of V-Belt drives to *perform whatever task may be required.*

Phone for a Gates Field Engineer

Only under exceptional circumstances, of course, will you ever need belts of special construction. But, more often, some drive in your plant may not be operating quite as it should. Or you may have a particularly difficult drive to design. Again, you may want to be sure what size and construction of V-Belts will give the most efficient and the lowest cost service on a certain drive. In any case, you have only to phone a Gates Field Engineer, *always near you* in all industrial centers.

Just look in your phone book under "Gates Rubber." A Gates Field Engineer will come right to your plant and put at your service the full benefits of Gates V-Belt knowledge and experience *without the slightest obligation!*

ENG-518

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ENGINEERING OFFICES AND JOBBER STOCKS IN ALL INDUSTRIAL CENTERS

THE GATES RUBBER COMPANY
The World's Largest Makers of V-Belts
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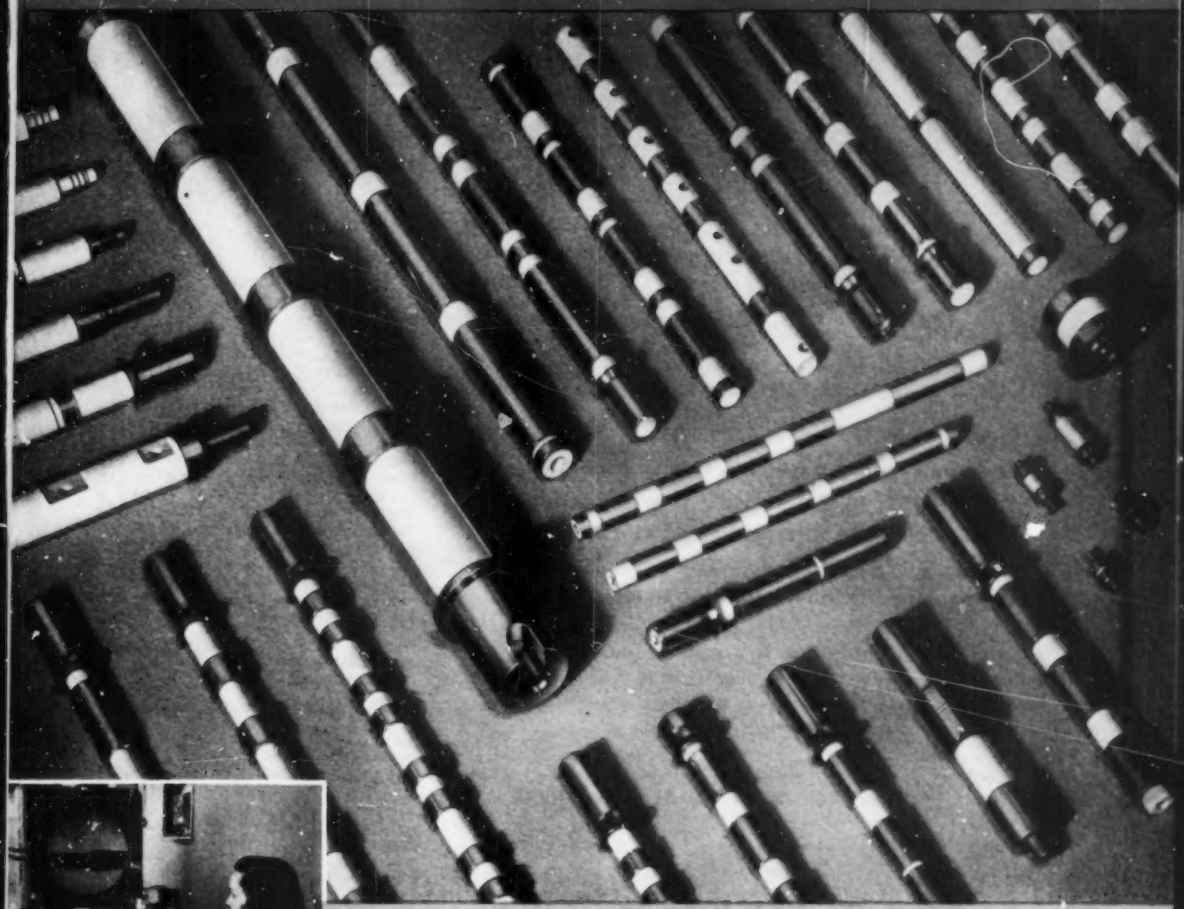
AlSiMag® PRECISION

METAL-CERAMIC COMBINATIONS



Alignment of metal ceramics checked by contour projector.

• American Lava Corporation has the skill and equipment and the experience required to produce PRECISION metal-ceramic combinations.

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. . REDUCE FINISHING TIME—
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- Do your castings assemble freely and within tolerance limits?
- Do your castings fit machining fixtures properly, consistently?
- Are your finish allowances held to a minimum?

INTERCHANGEABILITY has long been recognized as the forerunner of mass production. Unitcast daily production is held to the specified dimensional tolerances, assuring you this very important advantage.

UNITCAST ENGINEERS CONTINUE TO BE AT YOUR SERVICE

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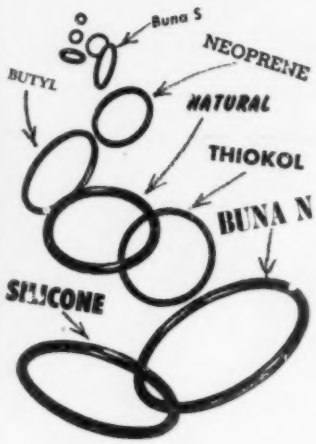
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

SPECIAL 'O" RINGS

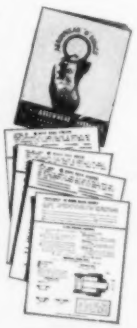


Many modern mechanisms present designers with new and difficult sealing problems created by unusual operating conditions. Frequently, special "O" rings are required, to insure a reliable seal in applications where extremes of temperature or very high pressures are encountered, or where the seal is exposed to fluids, gases, or chemicals which would damage a standard ring. Precision "O" rings moulded from Arrowhead special compounds have solved countless critical sealing problems. If you have a tough one, your inquiry is invited. It will receive the personal attention of our Director of Engineering Research.

GET THESE VALUABLE ENGINEERING AIDS

1. "O" RING MANUAL — *Contains illustrated design information and data on the selection, installation and proper use of "O" rings.*

2. DATA SHEETS — *Work sheets to assist designers in the selection of proper ring and most suitable compound, or in determining cause of "O" ring failure. Provides expert technical advice at no obligation.*



Write Dept. R-2

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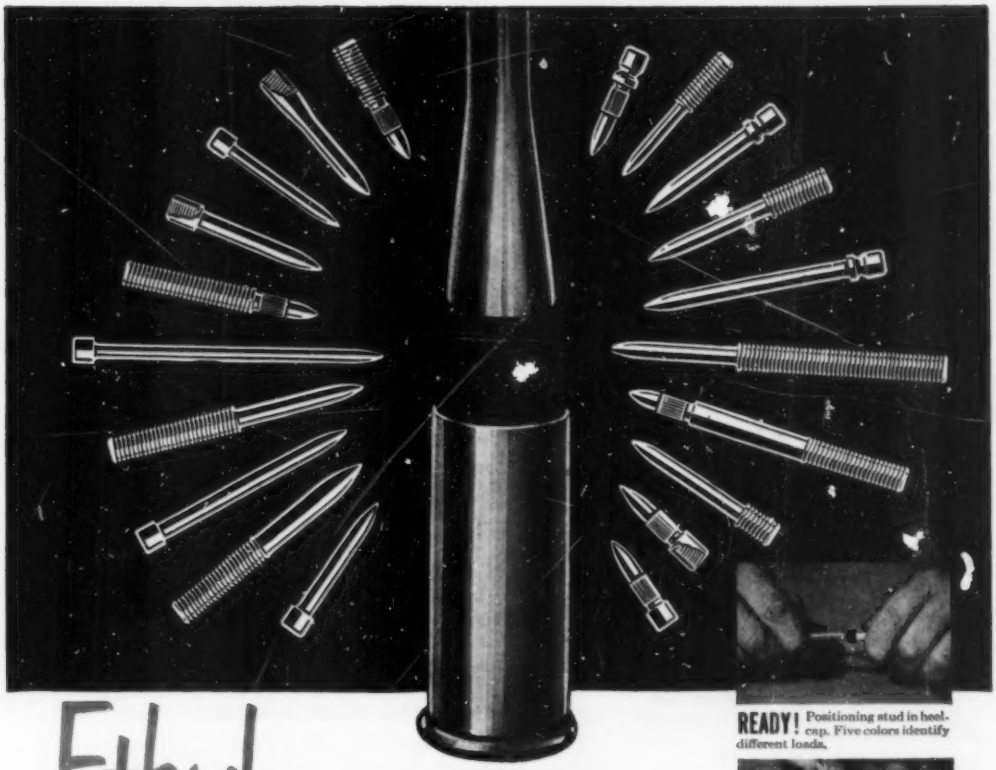
RUBBER COMPANY
DOWNEY (Los Angeles County) CALIF.

A DIVISION OF NATIONAL MOTOR BEARING CO., INC.



Ethyl CAPS THEM ALL!

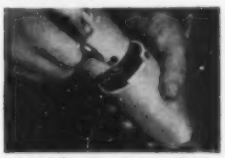
Ethyl cellulose caps this cartridge, the ammunition for one of industry's newest power tools—the Remington Stud Driver. A tiny heelcap molded with Hercocel* E positions a hardened steel stud driven by an explosive force capable of penetrating structural steel ¾-in. thick.

For this demanding job, no other plastic affords, at comparable cost, all the advantages of Hercocel E. It won't crack or shatter when the Driver is fired. There's no pickup of the plastic in the gun barrel. Hercocel E will retain its shape under widely varying climatic conditions and during long periods of storage, yet is resilient enough to assure a snug fit for twenty different types of studs produced to commercial tolerances.

Hercocel E takes tough jobs like this in its stride. Perhaps this versatile, quality plastic can help you. Hercules will be glad to provide design and technical assistance in adapting it to your individual needs. Your inquiries are invited.

HERCULES POWDER COMPANY Cellulose Products Department, 904 Market Street, Wilmington, Del.

READY! Positioning stud in heelcap. Five colors identify different loads.



LOAD! Loading Driver. Triple safety device prevents accidental firing.

FIRE! Driver requires no auxiliary power, has minimum recoil.

MOLDABILITY
SHOCK RESISTANCE
DIMENSIONAL STABILITY
LIGHTWEIGHT
COLORABILITY

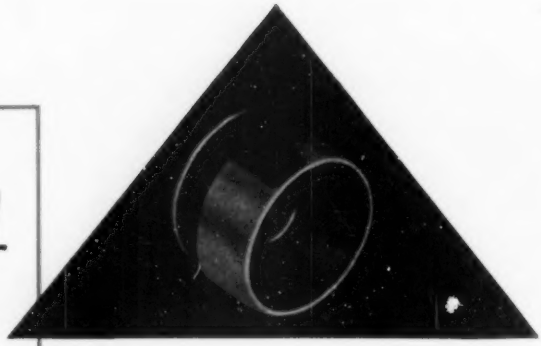
HERCULES Cellulosic Plastics

*TRADEMARK

Plastic heelcap molded with Hercocel E by Consolidated Molded Products Corp., Scranton, Pennsylvania, for Industrial Tool Division, Remington Arms Company, Inc., Bridgeport, Conn.

CPS1-7

POWDER METAL is good in the clutch



This centrifugal clutch assembly for fractional horsepower motor-drives was *designed* for powder metal production.

Cup and flange offer high friction properties because of the iron-base powder metal surface.

Shoes of leaded iron give maximum relative friction.

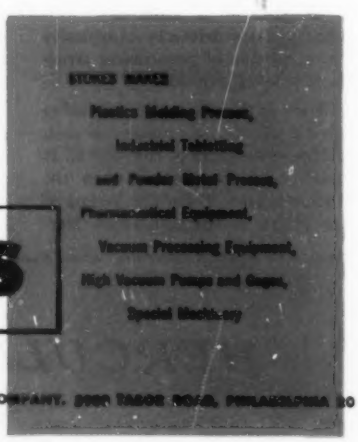
Porous leaded bronze bushings assure self-lubrication for the life of the part.

All this . . . and low cost too! Powder metal cost is far below that of all other manufacturing methods for this part.

Often powder metal production is ideal. Often a little redesigning suits a part for the powder metal process. Then the manufacturer gets the benefit of special characteristics, high production, fine tolerances without machining . . . and low cost.

Take nothing for granted however. Talk with experts . . . for example, Stokes engineers, who make no parts, but make the presses. Stokes will guide you in design and materials, calculate your savings, or refer you to a skilled powder metal processor.

Parts illustrated were made by The Wellmet Co., Kent, Ohio



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NEW PRINCIPLE of GUIDEROL

...solves your TOUGHER bearing problems

The McGill GUIDEROL Roller Bearing is especially designed to take advantage of the greater capacity of cageless roller bearings — without the danger of roller skewing. This new principle of bearing construction features guided rollers that overcome skewing tendencies and eliminate the need for space wasting cages. Also a much more rigid bearing results from extra long rollers that provide load support virtually the full width of the races. With GUIDEROL Roller Bearings you can expect rugged service with precision efficiency and longer life for your tougher bearing problems. Ask our engineers for the complete GUIDEROL story.

GUIDED ROLLERS PREVENT SKEWING — BINDING

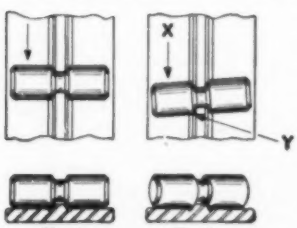


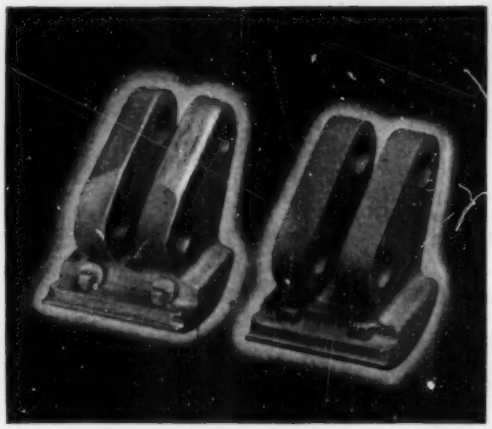
Fig. A Fig. B

A guide rail on the inside diameter of the outer race maintains roller alignment. Normally no correction is required. Should misalignment cause tendency to skew, the guide rail touches grooved rollers back into position by momentary contact at Y. X indicates direction of roller rotation.

Bulletin GR-50 lists proposed standard sizes in CT Series (interchangeable with cylindrical type dimensions) for FT Series (interchangeable with ordinary needle type dimensions). Write McGill Manufacturing Co., Inc., 201 No. Lafayette St., Valparaiso, Indiana for your copy.

McGILL® precision bearings

Which one is investment cast?



They may look alike but the part at left was machined from a tool steel forging and cost 36% more to produce than the tool steel investment casting at right.

Tolerances
as close as ±.002" were maintained on this casting and were equivalent to the machined tolerances.

Tensile strength tests
showed no loss in strength from replacing the forging with tool steel casting.

Investment casting
proves economical by eliminating machining, handling of raw materials, service failures and spoilage.

Investment casting
results in substantial economies in producing metal parts of all kinds, especially those whose intricate design or material used make it impossible or costly to machine.

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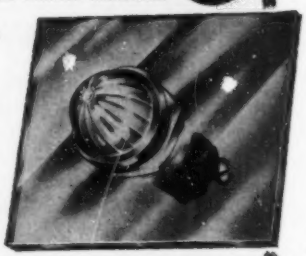

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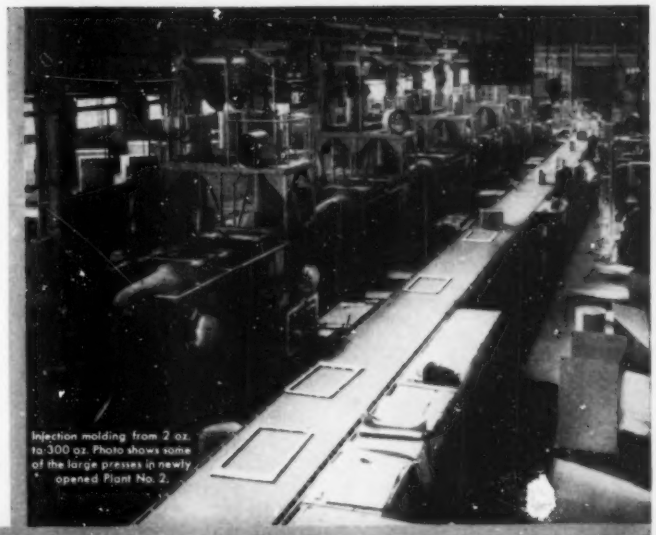
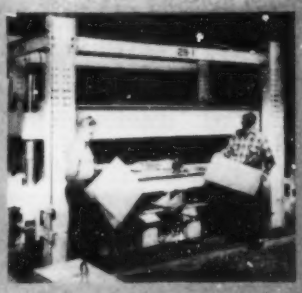


Injection molding from 2 oz. to 300 oz. Photo shows some of the large presses in newly opened Plant No. 2.



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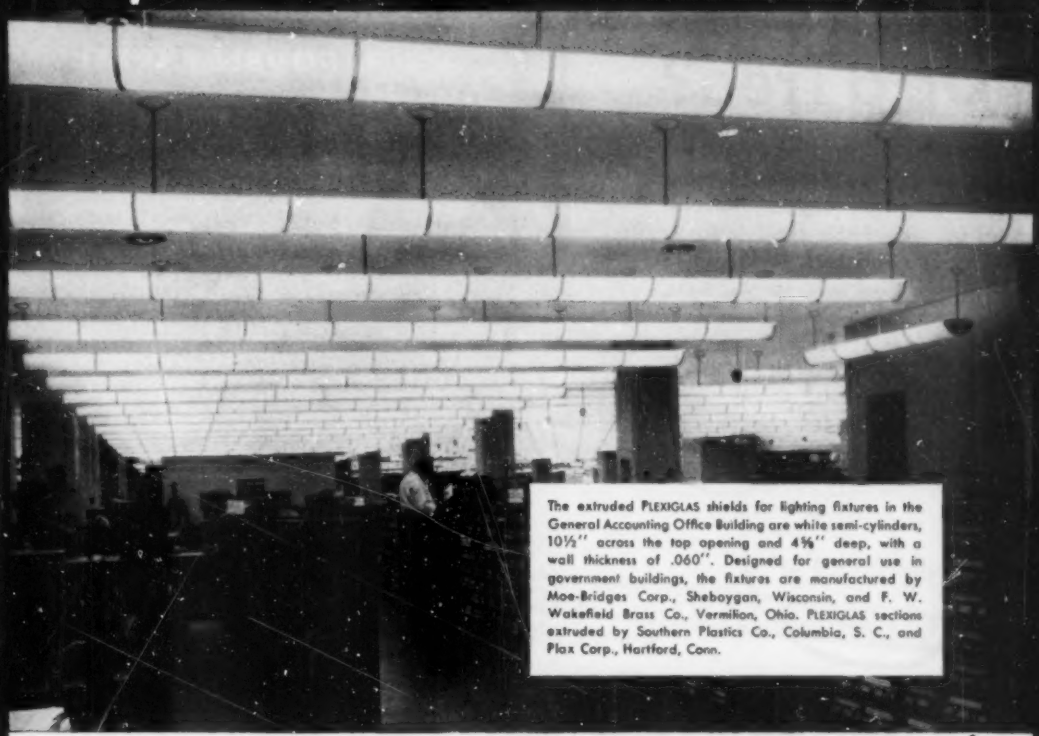

The extruded PLEXIGLAS shields for lighting fixtures in the General Accounting Office Building are white semi-cylinders, 10½" across the top opening and 4⅝" deep, with a wall thickness of .060". Designed for general use in government buildings, the fixtures are manufactured by Moe-Bridges Corp., Sheboygan, Wisconsin, and F. W. Wakefield Brass Co., Vermilion, Ohio. PLEXIGLAS sections extruded by Southern Plastics Co., Columbia, S. C., and Plax Corp., Hartford, Conn.

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AN STAINLESS STEEL FASTENING SELECTOR
In listing below, find AN number and note kind of fastening. Then, in proper window, set AN number and read data.
NUTS
NUMBER
NOM. SCREW SIZE
THD PER IN.
CAT. PAGE
AN 310 C18 1 1 8 12 22
See other side for RIVETS COTTER-PINS WASHERS
Prices and deliveries on request
SCREWS
NUMBER
NOM. SCREW SIZE
THD PER IN.
CAT. PAGE
AN 501 C1 #1 72 11
Last DASH NO indicates length in sixteenths inch
AN3 to AN20 Hexagon Head, Fine Thread, Class 3 Fit Aircraft Bolts
with hole drilled in shank
C—Corrosion Resisting Steel (Stainless Steel) to Spec AN-QQ-S-770, Condition QT, Class II (Type 431)
H—Indicates drilled hole in head of Bolt
A—Indicates no drilled hole in shank of Bolt
Last Dash No.—Refer to drawing for length of Bolt
Number Size Thd./In. Number Size Thd./In. Number Size Thd./In.
AN3 10 32 AN7 7/16 20 AN14 7/8 14
AN4 1/4 28 AN8 1/2 20 A1416 1 14
AN5 5/16 24 AN9 9/16 18 AN18 1-1/8 12
AN6 3/8 24 AN10 5/8 18 AN20 1-1/4 12
AN12 3/4 16
AN310 Castellated Nuts, Fine Thread, Class 3 Fit
AN315 Hexagon Plain Nuts, Fine Thread, Class 3 Fit
AN316 Hexagon Double Chamfered, Double Countersunk Check Nuts, Fine Thread, Class 3 Fit
AN320 Hexagon Shear Nuts, Fine Thread, Class 3 Fit
AN340 Machine Screw Nuts, Coarse Thread, Class 2 Fit
AN345 Machine Screw Nuts, Fine Thread, Class 2 Fit
AN381 Corrosion Resisting Steel Cotter Pins to Spec FF-P-386a, Amendment 2, Type
AN427 100° Flat Countersunk Head Rivets
C (Type 302)
F—Corrosion Resisting (Stainless) Steel to Spec AN-W-24, Grade G, Condition
A (Type 302 or Type 304 annealed)
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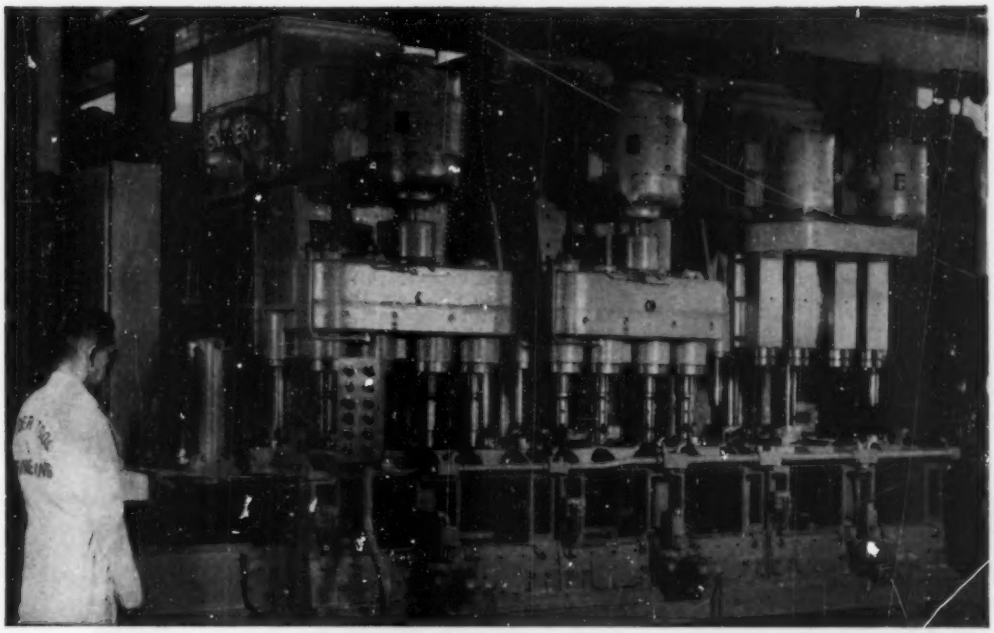
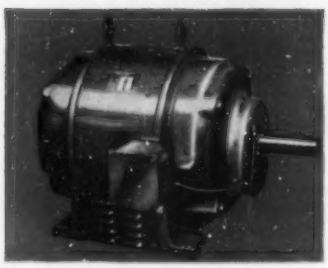


Three jobs done, instead of one!



Howell Type F Motor. A high slip, high torque motor designed for punching and boring operations. Sizes ½ to 200 H.P. in open frames; ½ to 125 H.P. in enclosed frames.

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Howell engineers worked closely with this manufacturer to provide the right type and size motor for each application. Two 15 H.P. and two 5 H.P. Howell Industrial Motors supply dependable power for the twelve boring spindles. A 7½ H.P. Howell motor operates each of the three hydraulic pumps which control the rough, semi-finish and finish heads. Each motor was engineered for its job!

This is a typical example of the service Howell offers you. We will work with you, both in your plant and at Howell, to design precision-built, quality motors for your jobs.

Our research facilities, engineering experience and manufacturing skill are at your service. May we help you?

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HOWELL Red Band MOTORS

HOWELL MOTORS

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for reduced finishing, faster assembly, lower costs

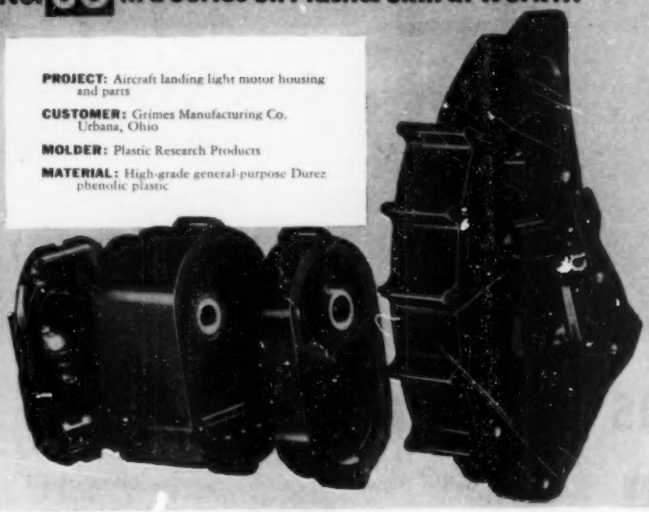
No. 30 in a Series on Plastics Skill at Work...

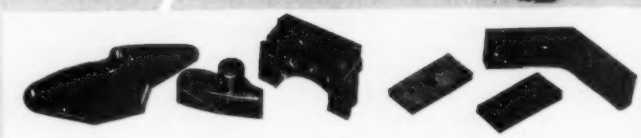
PROJECT: Aircraft landing light motor housing and parts

CUSTOMER: Grimes Manufacturing Co. Urbana, Ohio

MOLDER: Plastic Research Products

MATERIAL: High-grade general-purpose Durez phenolic plastic





MECHANISM for lowering and raising landing lights from wings of aircraft is housed in four major moldings of Durez. Six smaller parts are used in the assembly. Molding-in of flanges, holes, ribs, and numerous metal inserts effects impressive savings. High-grade general-purpose Durez has the needed mechanical & electrical properties.

● "Now if only they'd made a plastic rugged enough for this assembly!"

Who hasn't heard this in design plan meetings? Odd thing is, often "they" DO make such plastics. Durez does especially, because we continue as always to specialize in the tough and versatile phenolics.

The main point, as shown in these aircraft landing light parts, is to counsel with a custom molder early in the proceedings. Your molder can take over wherever you want him to. Rewards may include reduced finishing, simplified assembly, lower material costs, quicker delivery, better performance.

When Grimes Manufacturing Co. changed the major and minor parts of this assembly from metal to molded Durez, a lot of machining was eliminated. The self-insulating property of the plastic made added insulation unnecessary. Molded-in metal inserts contributed further to lower assembly costs and faster output.

The availability of Durez may give you and your molder a valuable time advantage in using phenolics. Why not talk over your requirements with him? He'll know which Durez molding compound is best for your job. For further information and technical assistance, our field staff is always at your service.

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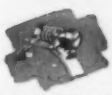

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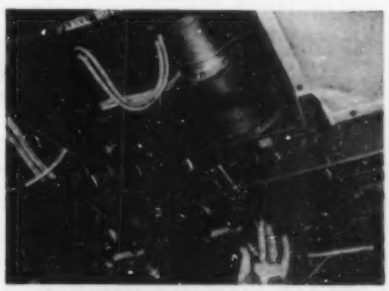

Breeze rotary actuator releases twenty 500 lb. parateiners from Fairchild Packet in 10 seconds.

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Elliott Engineering Service will help you select the type of Flexible Shafting and standard accessories which are best suited to your particular type of work. Inquiries are held in confidence, and this service is yours without obligation.

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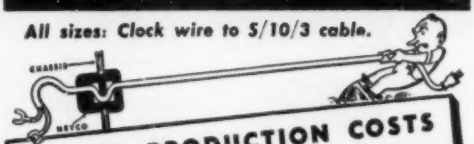

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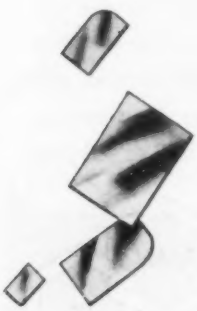

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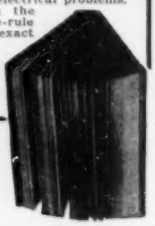

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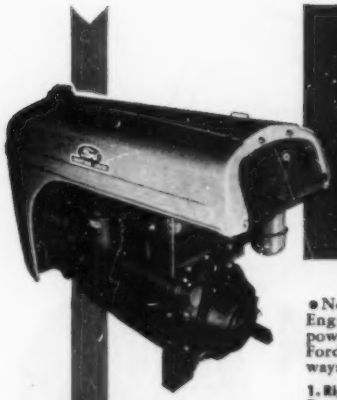

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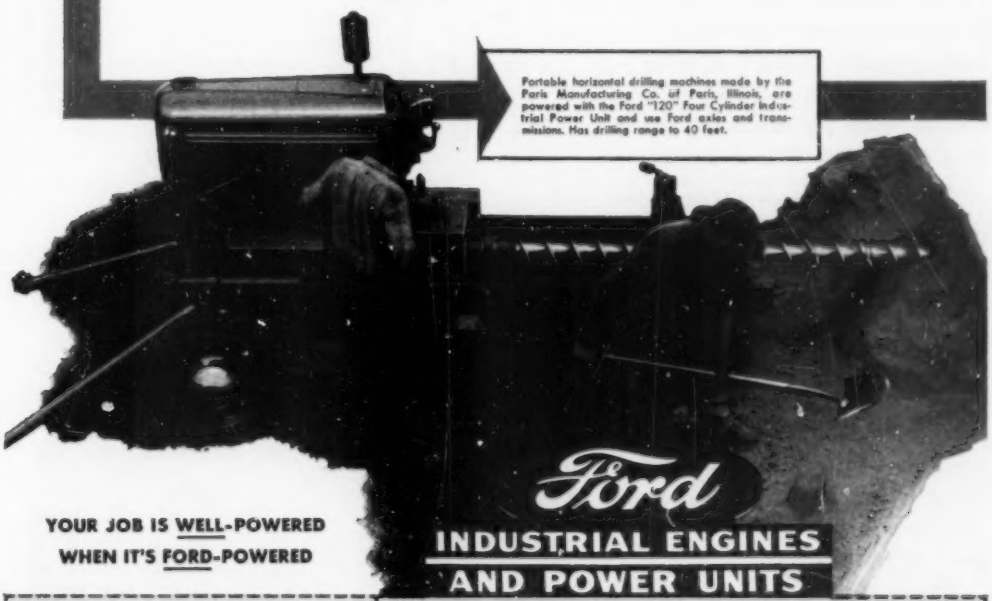

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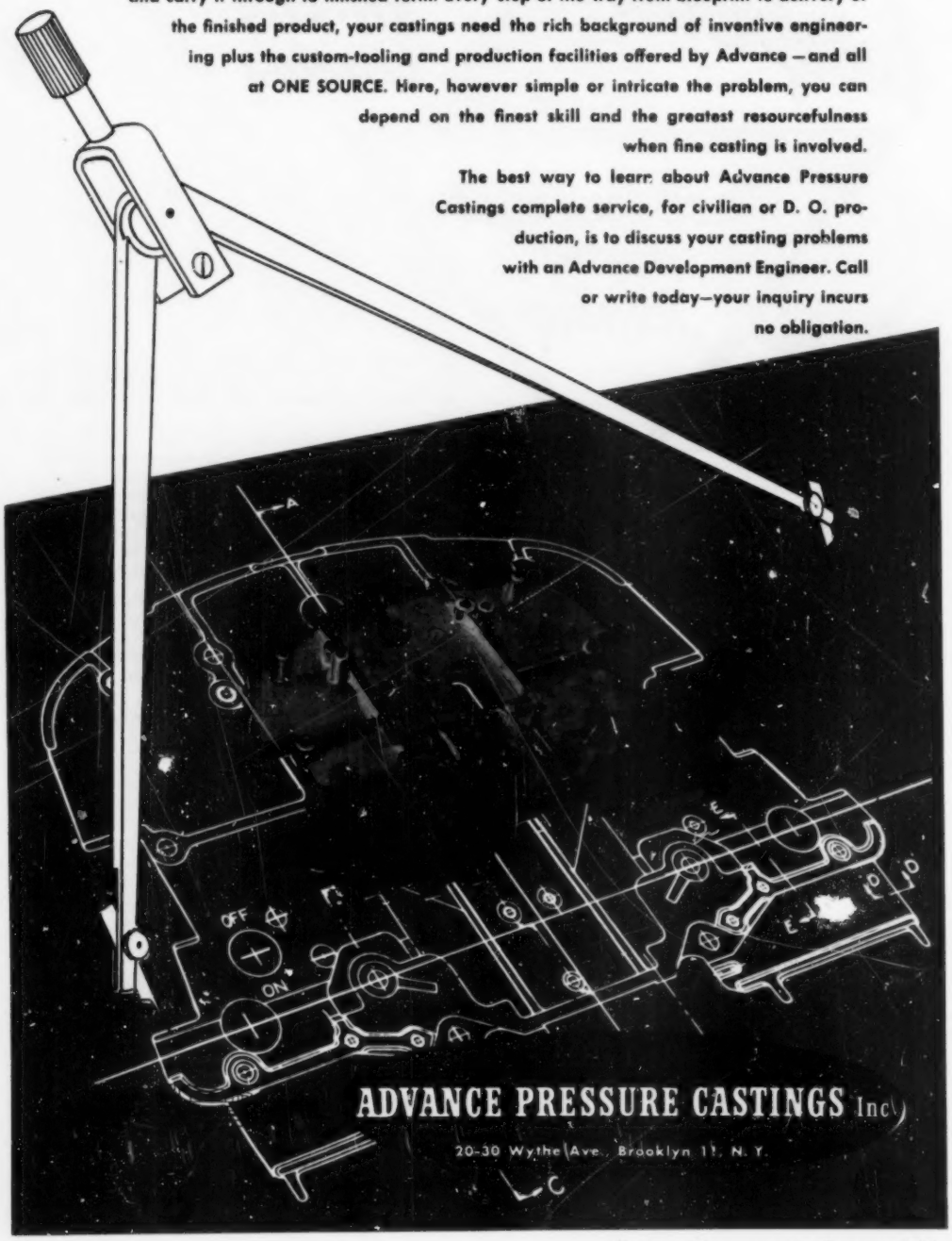

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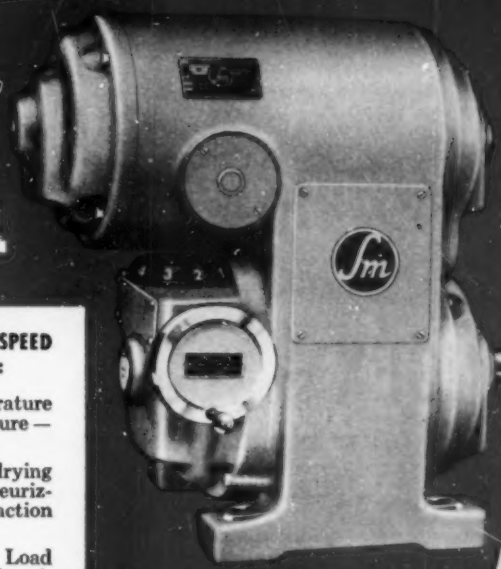

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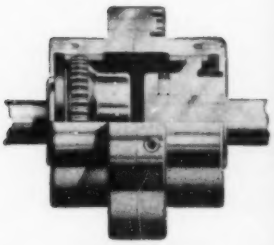

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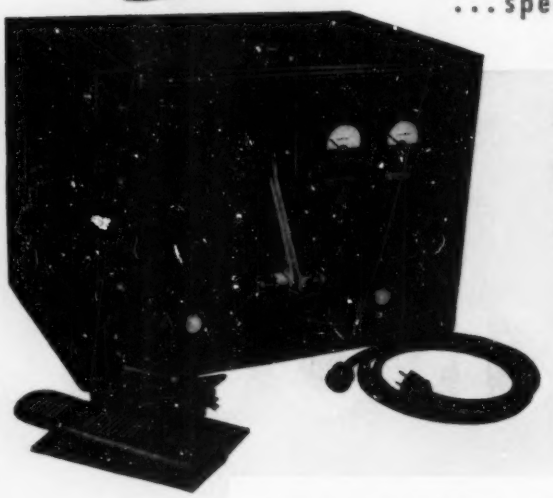

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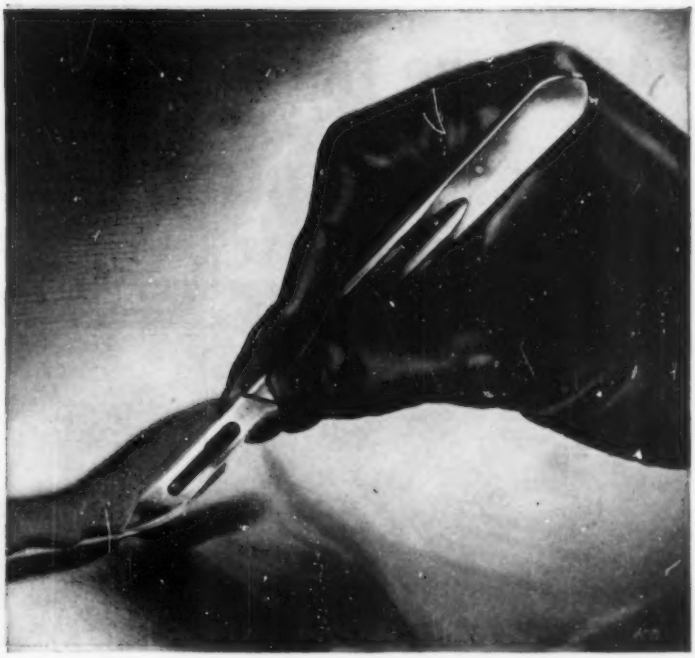

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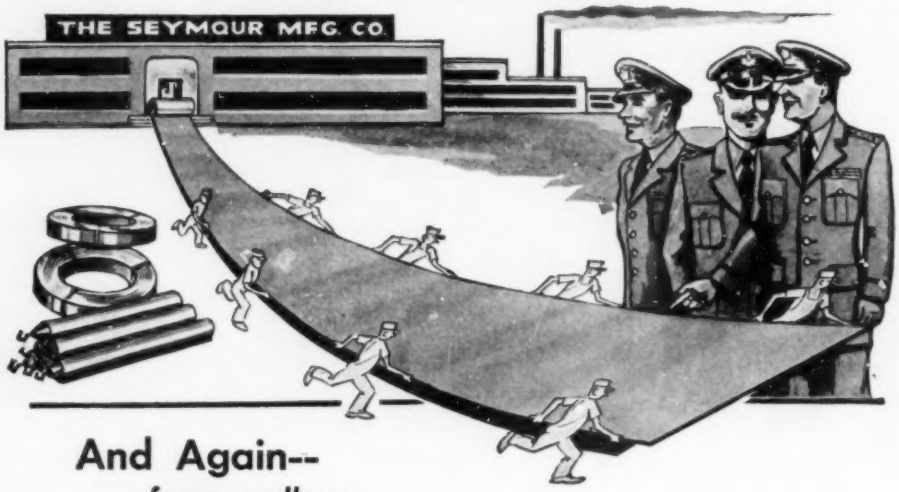

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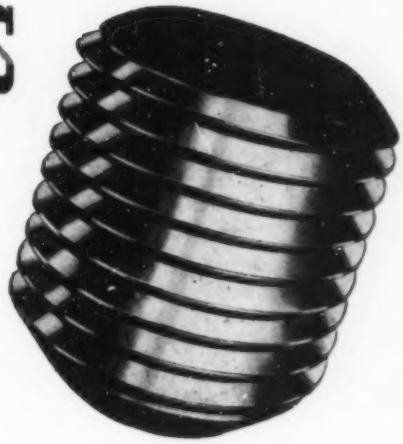

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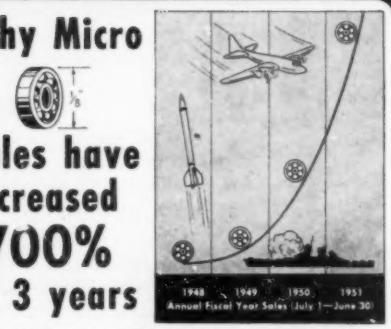

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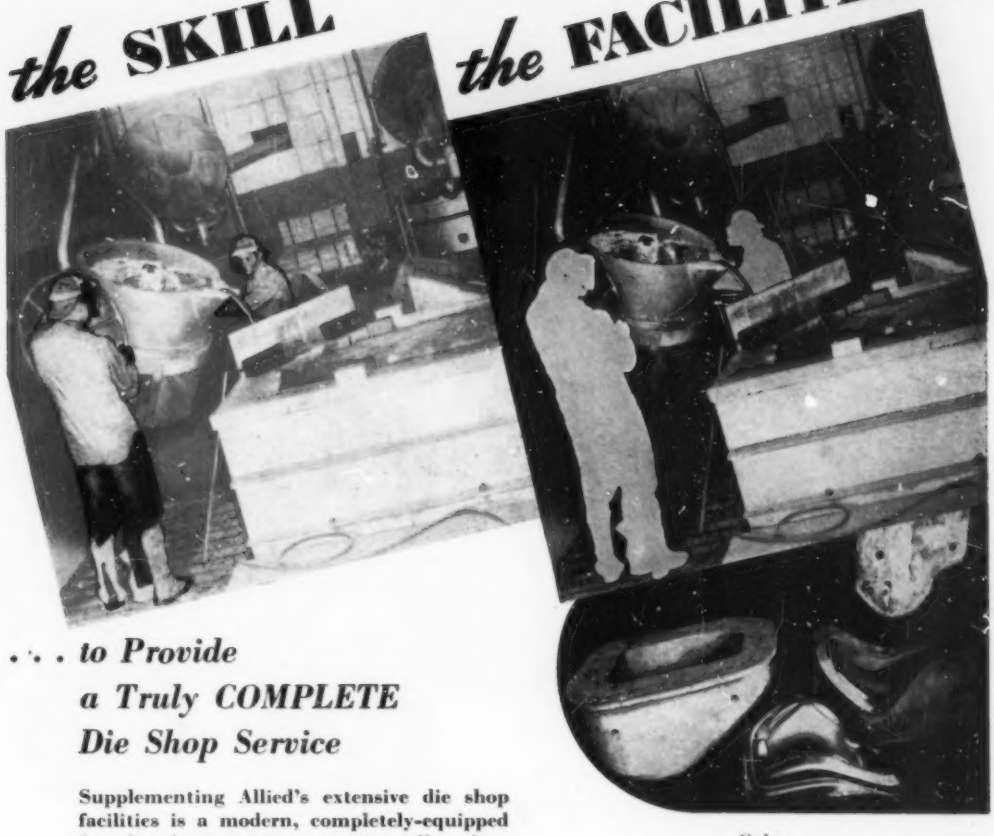
Applications involving critical weight, size and friction are best entrusted to the more than 85 types and sizes of Micro bearings. They are available in sizes as small as 1/8" O.D. and with tolerances to the millionths-inch precision of ABEC-7. Yet, they actually *cost less* than comparable unground bearings.

Write for Technical Bulletin No. 50

New Hampshire MICRO Ball Bearings, Inc.

3 Main Street, Peterborough, N. H.

the SKILL *the* FACILITIES



. . . *to Provide a Truly COMPLETE Die Shop Service*

Supplementing Allied's extensive die shop facilities is a modern, completely-equipped foundry for precision-cast zinc alloy dies. Here, thoroughly skilled and experienced personnel produce dies for experimental parts and short run production . . . quickly, accurately and economically.

The operation of this foundry is typical of Allied's policy to provide in all of its plants and in every department a *full* measure of service to its customers.

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HARDENED AND PRECISION GROUND PARTS • SPECIAL COLD FORGED PARTS • STANDARD CAP SCREWS • SHEET METAL DIES FROM THE LARGEST TO THE SMALLEST • JIGS • FIXTURES R-B INTERCHANGEABLE PUNCHES AND DIES

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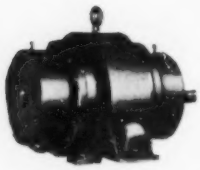
GUARD YOUR PRODUCTION AGAINST the Hazard of SPLASHING LIQUIDS

WITH

Century SPLASH PROOF MOTORS

Century 7½ HP Type RS Single Phase Repulsion Start Induction Brush Lifting Splash Proof Motor.

1 to 7½ HP Direct Current Splash Proof Motor.



150 to 400 HP Type SC Squirrel Cage Induction 3 Phase Splash Proof Motors.

30 to 100 HP Type SR Slip Ring Induction 3 Phase Splash Proof Motors.

1 to 125 HP Type SC Squirrel Cage Induction 3 Phase Splash Proof Motors.

3 to 25 HP Type SR Slip Ring Induction 3 Phase Splash Proof Motors.

1 to 20 HP Type CS Capacitor Start Induction Single Phase Splash Proof Motor.

Keep the vital parts of your motors dry —even when the full force of a hose is turned directly on them. Century Splash Proof motors eliminate production losses due to dripping or splashing liquids or falling solids. They also protect against rain, snow, sleet or hail on outdoor installations.

Century Splash Proof motors are available in a wide range of types and sizes for all popular applications. Other types and ratings are available to meet your electric power requirements. You can specify Century motors with confidence.

Century motors are built in sizes ⅙ to 400 horsepower.

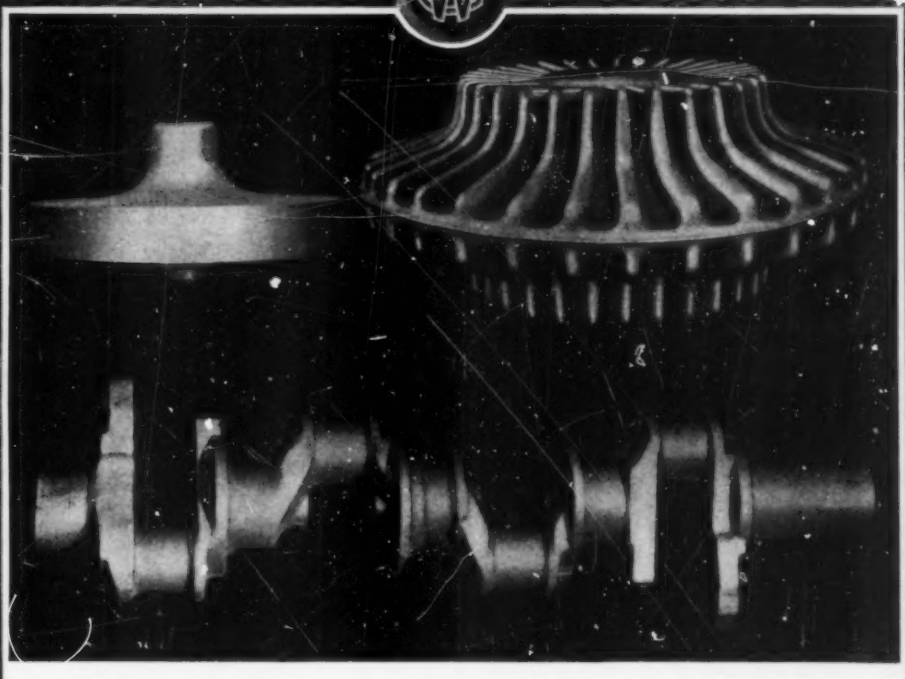
Century C MOTORS

697

CENTURY ELECTRIC COMPANY IS CELEBRATING ITS 50th YEAR IN THE ELECTRICAL INDUSTRY

CENTURY ELECTRIC COMPANY, 1806 Pine Street, St. Louis 3, Missouri

Offices and Stock Points in Principal Cities



Wyman-Gordon—specialists in the vital forgings of the internal combustion engine since its inception--is today the largest producer of crankshafts for the automotive industry and of all types of forgings for the aircraft industry. Be it crankshafts and other vital forgings for the piston type engines or turbine wheels and impellers for turbo jets—there is no substitute for Wyman-Gordon experience.

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ALUMINUM

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IRON and STEEL

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WRITE TODAY FOR ALUMIBOND BOOKLET

ARTHUR TICKLE

ENGINEERING WORKS

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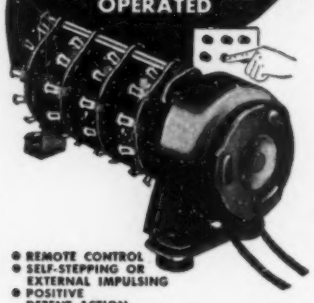
LEDEX

RELAYS and CIRCUIT SELECTORS

ROTARY SOLENOID OPERATED



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- SELF-STEPPING OR EXTERNAL IMPULSING
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for REMOTE CONTROL of MULTIPLE COMPLEX CIRCUITS

Many versatile designs of stepping, counting, adding and subtracting, latching, and *circuit selecting* relays are made possible by the combination of the Ledex Rotary Solenoid and wafer type rotary switches. Self-stepped or externally impulsed, the device is immediately adaptable to many remote control applications. A choice of wire sizes permits a wide range of operating voltages and power requirements. Various types of mountings further increase its adaptability. In addition to its positive control of multiple, complex circuits, a reserve of mechanical power is available for the performance of duties other than switching operations.

We supply to quantity users and solicit the opportunity to be of assistance in solving multiple circuit relay problems.

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Saves Time, Money, Material

ON CHICAGO CARTON COMPANY LAMINATING MACHINE

AND CUT-OFF

Oilgear drive installed in 1934 operates 16 hours daily at low cost. Gives maximum production on all stocks with little spoilage or non-productive time

A laminating machine and a cut-off in the plant of the Chicago Carton Company are driven in synchronism by Oilgear Fluid Power Equipment installed in 1934. A trip to the plant reveals today the compact, sturdy Oilgear equipment on the lower floor performing quietly, efficiently and continuously 16 hours a day in the necessarily humid atmosphere. Maintenance records indicate a total expenditure of $93.21 during the 16 years for service and parts, less than $6.00 a year. Because of the full flexible speed range and easy controllability of the Oilgear drives, the laminating machine is operated at speeds that best fit the type of board being processed and the cut-off drive follows in synchronism to cut stock into uniform lengths.

Another Oilgear feature important here is the unusual speed with which the laminating machine drive and cut-off drive can be started and stopped. This feature of Oilgear smooth, high speed acceleration and quick hydro-dynamic braking reduces non-productive time and cuts spoilage of sheets to a bare minimum.

On the basis of the 16 year performance of Oilgear, the Chicago Carton Company recently installed another Oilgear drive on a new 125 hp installation.

Time after time, Oilgear demonstrates its superiority and dependability on variable speed drives. Oilgear Fluid Power has many advantages. Investigate them now. THE OILGEAR COMPANY, 1571 W. Pierce St., Milwaukee 4, Wis.

UPPER—Oilgear 40 hp Variable Speed Drive with electric pilot motor remote control and oil reservoir base.

LOWER—Oilgear 7½ hp Variable Speed Drive with automatic control to synchronize cutter speed with speed of laminating machine drive.

Oilgear

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PUMPS, TRANSMISSIONS, CYLINDERS AND VALVES

THREE SAFE, SURE CONTROLS for HAZARDOUS LOCATIONS

Enclosed in Approved Blast-Proof, Dust-Tight Housings

TYPE EJO THERMOSTAT A precisely adjustable control. Narrow calibrated ranges for liquids or gases. Adjustable ranges, 120 F or 250 F between limits of −120F and 600F. Ratings AC 1200 watts 125-250 V AC. Uses any United remote bulb assembly.

TYPE EJR VACUUM SWITCH For close differential control on exposed applications. Ranges from 0-180 psi pressure, 30" Hg vac to 20 lb. press. Diff. 4" WC to 2 lb. adjustable or fixed at customer's option.

TYPE EGL PRESSURE CONTROL A rugged pilot switch for industrial uses involving the control of air, gas and liquids. Ranges from 0-350 psi. Diff. from 2-15 psi, electrical ratings AC 1200 watts 125-25 V AC.

All controls tapped for standard pipe fitting. All may be mounted in any position.

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UNITED ELECTRIC CONTROLS COMPANY
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STANDARD & SPECIAL THERMOSTATS & PRESSURE SWITCHES

how SpirOlox Retaining Rings withstand repetitive shock loads without jumping the groove!

Unique Spirolox *two-turn* construction enables it to resist shock loads and thrust forces up to its own shear strength. Under thrust, the coils are actually "squeezed" together, thus forming a "friction lock" which makes Spirolox stay in the groove. Blueprint below points out how this "stay-put" characteristic is put to work in a Coaster Brake Assembly. Collar rides to Spirolox, making it necessary for retainer ring to withstand repeated shock loads due to brake application without shearing or jumping groove.

see our CATALOG 51

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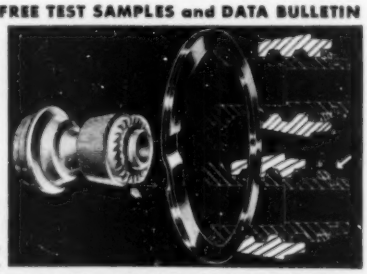
Get simpler, more compact design; elimination of trouble spots; removal of awkward parts and costly machining!



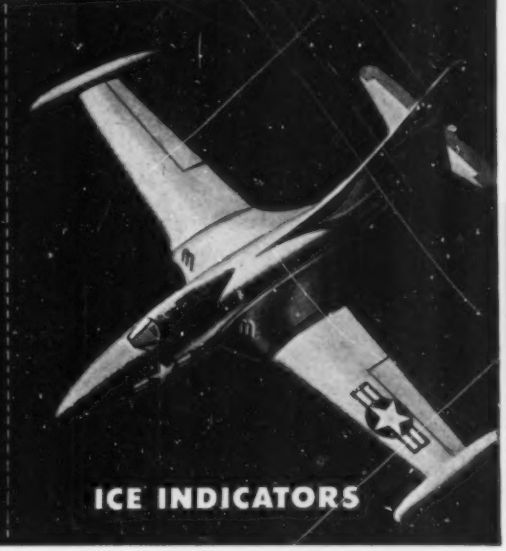
WRITE RAMSEY CORPORATION, St. Louis, 8 Mo.

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!

Save time in designing

ELECTRICAL HEATING ELEMENTS

FOR IRONS...



ICE INDICATORS

and 1001 other products!

These days when you have so many problems to solve—and so little time to devote to them—why wrestle with jobs that are quickly done by experts?

It's no cinch to determine the proper heating element for every application. There are sheath metals, terminals, switches and mountings to worry about. Heat patterns, heat losses and allowable "heat up" time to calculate. To say nothing of voltages, wattages, thermostats and relays! That's why we suggest you bring your problem to "heating headquarters".

We have a wealth of information on heating problems already in our files—information it might take you weeks or months or even years to develop on your own. That's because we're specialists at engineering and controlling electric heat. Our men work at it every day . . . for many different manufacturers . . . of many different products.

As a result, we're uniquely qualified to help you. You'll find TK * Heating Units in everything from coffee makers to waffle bakers, clothes dryers to deep fat fryers, melting pots to molding presses.

And in the current defense build-up, we're proving again, as we proved in World War II, that we're equally at home with heating elements for guns, gun directors, boat galleys and a host of other aircraft, marine and submarine applications.

So, when you need fast answers, turn your electrical heating questions and your design and procurement problems over to us. You'll get prompt, "personalized" service—and you'll save time all along the line! *T. M. Reg. U. S. Pat. Off.

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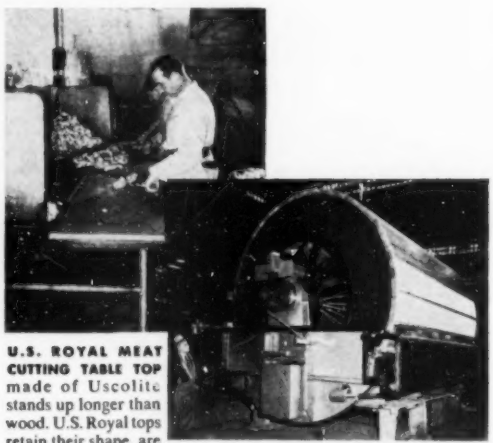
What's U. S. Rubber doing with Plastic Pipe?

Giving it extremely high impact strength, for one thing. A single .44 cal. revolver bullet, fired at a distance of 20 yards, merely dented this piece of pipe, which is made of U.S. Rubber's new plastic, Uscolite. This amazingly strong, lightweight, versatile piping is easy to handle, won't break if dropped. Furnished in standard lengths, it can be cut to length and threaded on the job. Uscolite is resistant to most chemicals. For more information, write to address below. In Canada, write to the Dominion Rubber Company.



U.S. ROYAL MEAT CUTTING TABLE TOP made of Uscolite stands up longer than wood. U.S. Royal tops retain their shape, are easier to clean.

THIS CONKEY FILTER, part of the sanitation system of a midwestern city, is equipped with Uscolite piping. Uscolite handles corrosive acids, alkalies, salts.

PRODUCT OF

U.S. RUBBER

SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Design Engineers Agree:

Close valve coupling makes for greatest pneumatic efficiency

And The Bellows Air Motor

Is the only Air Cylinder with a Built-in Valve

In pneumatics operation the more remote the valve from the cylinder the greater the possibility of erratic cylinder performance. In the Bellows Air Motor the valve is integral with the cylinder. This integral construction means *instant* action. No lag, no time delay, no air flow restriction. Integral construction means *positive control.* Directional control . . . speed control. Integral construction means *compactness.* Space saving design . . . simplified installation in cramped quarters, or on moving machine elements.

Bellows Air Motors are made in five bore sizes: 1¼", 1¾", 2½", 3⅜" and 4½". Any stroke length. They are available with either the built-in Bellows manually operated valve, or the Bellows Electroaire Valve*, a low-voltage electrically controlled air operated valve hardly bigger than a package of cigarettes, vet guaranteed for life against solenoid burnout.

For instant action, positive control, and compactness in pneumatic circuits, there is only one answer: The Bellows Air Motor — the air cylinder with the built-in valve.

* T.M. Reg. Pat. Pending

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THESE FREE BOOKLETS

Complete technical data on the Bellows Air Motor and the Electroaire Valve. Address: The Bellows Co., Dept. PE1051, Akron 9, Ohio

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1807

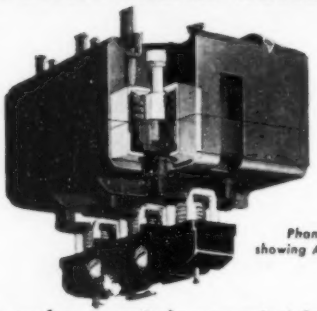
Field engineering offices in all principal cities of the United States and Canada.

It's All NEW! CLARK TYPE CY AC Motor Starter

...with the sensational NEW multi-turn magnetic blowouts...

...and TWIN-BREAK CONTACTS

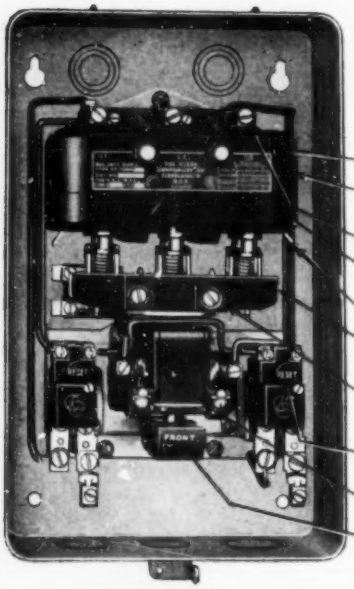
Here, for the first time is a rugged AC magnetic starter that provides the extra protection and dependable operation of "Mill-Type" heavy-duty construction and design.



Phantom view showing Arc-shield

another CLARK FIRST!

Type "CY" starters employ an entirely new principle of arc interruption. The arc is extinguished by the effect of the blow-out coil, *concentric with the contact*. The magnetic field quenches the arc either by lengthening or confining it. In its *forced rotation* it moves continually from a hot to a cold spot—minimizing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of hot gases between wiring terminals—minimizing phase-to-phase failures*.


One piece upper arc shell protects terminals from hot gases
Magnetic arc interrupters with steel arc chambers
Pressure type terminals line and load
Arc shields of inorganic non-carbonizing material
Finger clips for easy contact inspection
Silver double break control circuit contacts
Captive screws in contact arm
Melting alloy type overload relays
Easy coil replacement—only two screws and one pin to remove
Vertical lift magnet with steel guide uses no springs
FRONT

Open View

The Maintenance Man's Dream!

- No filing, dressing or cleaning of contacts!
- No tools necessary to inspect contacts!
- Easy to change moving contacts!
- Stationary contacts changed quickly!
- Remove only two screws and one pin to change coils!
- Remove only four screws to take out stationary magnet frame!
- Power circuit contacts available with springs in complete packaged service kits for ease in stocking!

*Magnetic blow-out coils are used on all size 2 and 3 Type "CY" starters. The same Mill-Type construction is used on sizes 0 and 1.

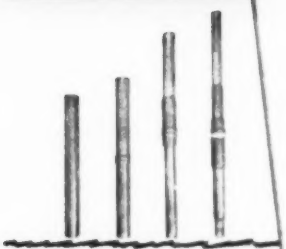
Let a CLARK application engineer show you what this new line of CLARK "CY" starters means to you in increased production and lower maintenance.

THE CLARK CONTROLLER CO.

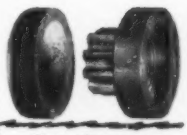
ENGINEERED ELECTRICAL CONTROL • 1142 EAST 152ND STREET, CLEVELAND 10, OHIO

NEW ECONOMIES IN COLD FORMING!

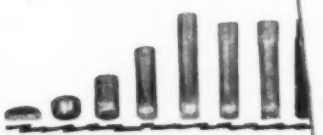
GET YOUR FREE BULLETIN TODAY!



Automotive drive shaft, produced by cold forming with aid of Bonderite and Bonderlube. Saves steel, machine time, man hours.



Close tolerance gear, with excellent physical properties, formed from Bonderite-treated coined blank in one extrusion.



Showing the progressive stages in cold drawing of steel 50 cal. cartridge cases, with aid of Bonderite.

Steel washing machine tub, drawn from sheet steel blank with aid of Bonderite.

SEE EXAMPLES AT OUR BOOTH H339, METALS SHOW, DETROIT

. . . FILLED WITH TIME, METAL, AND MONEY SAVING FACTS LEARNED IN PARKER'S 10 YEARS' EXPERIENCE IN THIS FIELD. Technical bulletin, illustrated, tells you how new Parker developments in products and techniques can help you make "impossible" draws and extrusions become economical production realities. A valuable book for executives, engineers, production men. Get your copy now!

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*

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fill in and mail Coupon today!

CHECK type of metal you are interested in cold forming.

- STEEL ☐
- ZINC COATED ☐
- STAINLESS ☐
- ALUMINUM ☐

Please send me, by return mail, my FREE copy of technical bulletin "Bonderite As An Aid in Cold Forming."

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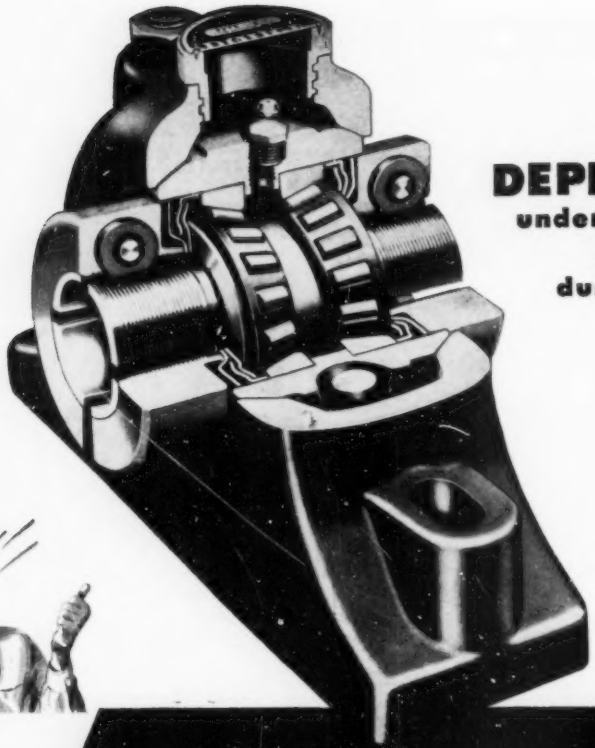

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under severest conditions of dust and dirt!

DODGE-TIMKEN

- Even under layers of grime, dirt and abrasive dust encountered in many production operations, the Dodge-Timken Type C bearing carries its power load smoothly, efficiently, without interruption—because it's
- Triple-sealed to prevent the entry of dust, however fine. Accurately machined steel seals keep dirt *out* and lubricant *in*.
- Dodge mounts, seals, houses Timken precision bearing units in rugged assemblies (four different types) to deliver a minimum of 30,000 hours uninterrupted service.
- Dodge Timken Type C Pillow Blocks are fully self-aligning, with both radial and thrust carrying capacity.
- Delivered fully assembled, adjusted and lubricated, ready to lock on shaft. Locking collars at both ends insure firm fastening.
- Normally available from Dodge Distributors' stocks, sizes from 1-7/16" to 4-15/16".

DODGE MANUFACTURING CORPORATION, 1200 Union Street, Mishawaka, Indiana

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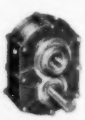
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER, your local Dodge Distributor for assistance on new, cost-saving methods. Look for his name under "Power Transmission Equipment" in classified phone book.

FIRST IN POWER TRANSMISSION MACHINERY!

V-BELTS AND TAPER-LOCK SHEAVES



TORQUE-ARM SPEED REDUCERS

ROLLING GRIP AND DIAMOND B CLUTCHES

SOLID STEEL CONVEYOR PULLEYS

NAME PLATE

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 SHEFFIELD AVENUE, CHICAGO, ILLINOIS

Light Section Plate And Steel Castings Joined To Produce 9½ Ton Structure

This 19,000 lb. high pressure unit for pumping gas is a good example of the flexibility in design available with composite fabrication.

Produced through teamwork of the customer and foundry, this redesigned unit combines light section plate, where additional strength is not needed, with steel castings.

On the front of the massive cylindrical casting, forming the body of the part, three blades are welded into place. The base is also made of steel casting and plate, welded to the main casting. Incorporated in the rear of the unit is the drive housing of light plate construction with a cast steel bearing welded in place.

* * *

Conversion of some of your parts to *foundry engineered* composite fabrications and cast-weld assemblies and *foundry engineered* steel castings — through close cooperation of your engineering department and the steel foundry — may result in more production, of better quality, in less time and with less metal.

Your steel foundry representative will welcome an opportunity to make available to you his company's long experience *plus* the full results of the development and research program carried on by the Steel Founders' Society of America.

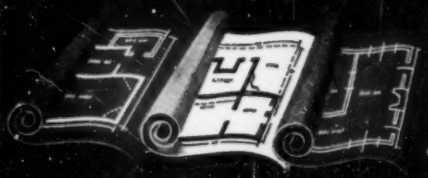
An Urgent Message About Scrap . . .

There is a serious shortage of iron and steel scrap. Your company can help insure the continued high production of all metal products by getting your scrap into the hands of your scrap dealer. Will you do what you can to help . . . now?

STEEL FOUNDERS' SOCIETY OF AMERICA

920 Midland Building Cleveland 15, Ohio

NOW! BY ANY PROCESS!



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Please send me free Venus *Technical Test Kit* with two Venus Drawing Pencils in these degrees: ( ) ( ).

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Company .....
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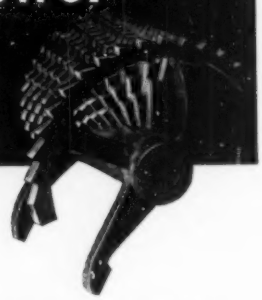
City ..... *State* .....

3 Times Stronger 90% Lower Cost



HERE is an outstanding example of what an Arwood precision investment casting can do.

This is a justifying cam used in a business machine and it was originally designed as a series of 18 stampings to be assembled by pinning and brazing. In its manufacture, Arwood was able to show a savings of 90% and at the same time triple the strength and wear-resistance of the cam. No hand filing or fitting is required in assembling the cast parts and all are completely interchangeable.

Perhaps you have a production problem that Arwood can help you solve. Our engineers, with years of experience in many industries, often are able to make valuable suggestions that result in important savings in manufacturing.

For more complete information about the accuracy, the lower costs and the versatility of precision casting, write for our booklet, "A Critical Survey of Investment Castings."

ARWOOD
PRECISION CASTING CORP.
68 WASHINGTON STREET • BROOKLYN 1, N. Y.

Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

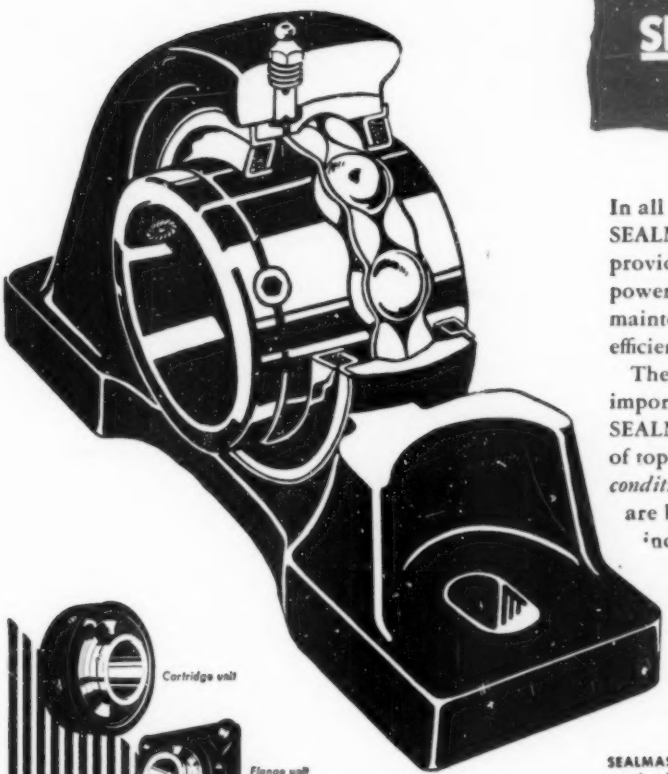
Wherever used...

THEY ADD

BUILT-IN PERFORMANCE

SEALMASTER

BALL BEARING UNITS



In all types of machines, SEALMASTER Ball Bearing Units provide smoother operation, reduced power consumption, minimum maintenance and general all-round efficiency.

The exclusive combination of important features found only in SEALMASTERS is the best assurance of top performance *under all conditions*—superior qualities that are built right into each individual bearing.

Write for your copy of Catalog 845 which gives dimensions, load ratings and other data on the complete line of SealMaster Bearing units. If you have a special bearing problem ask one of our bearing specialists to assist you.

SEALMASTERS' patented centrifugal seal retains lubricant and excludes dirt. Self-aligning bearing assembly permits alignment without seal distortion. Factory-lubricated, **ALL SEALMASTERS** are shipped *ready for use*. Patented locking pin and dimple prevents rotation of outer race in housing and positions unit for relubrication.

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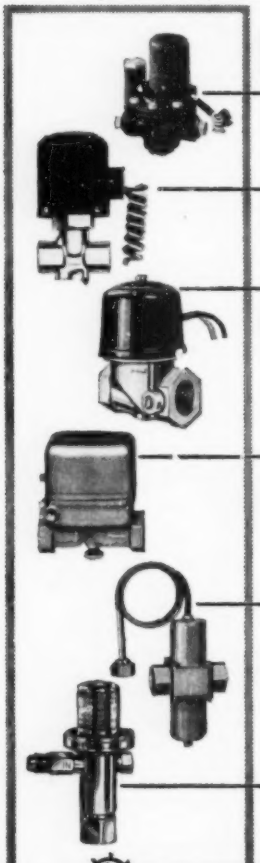
. . . SPECIFY

Control valves for air, gases, liquids or refrigerants must be completely dependable — particularly where automatic functioning of product or process is required. A-P offers years of experience, unexcelled engineering facilities, plus precision manufacturing methods and meticulous quality control to back up its guarantee of DEPENDABILITY in Service. A recognized leader in the field of flow-control, A-P offers a wide range of types and sizes — pressure, temperature or electrically controlled.



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SOLENOID VALVES

Heavy-duty, pilot-operated, industrial-type solenoid valves for water. Non-overheating moisture-proof coil, easily removable strainer and valve seat. Capacity to 3000 gal. per hr.

Multi-purpose solenoid valve. Handles air, water, or non-corrosive liquids and gases. Capacity up to 600 gal. per hr.

Rugged, long-life solenoid valve for low pressure air or gas control. Positive opening and seal-off, even with voltage or pressure variations. No sticking or gumming. Quiet, no-hum operation due to unique design.

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Designed primarily for refrigerant control, A-P expansion valves are adaptable to many applications where automatic control of temperatures or pressures is required. If you have a problem involving the control of liquid or gas flow in response to pressure or temperature changes, a standard, low-cost A-P expansion valve may provide an immediate answer.

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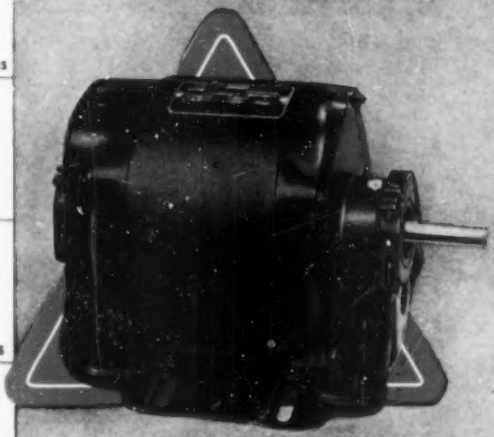

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the best running mate your product can have!

Good motors are the best assurance of good service from appliances. Every year, Delco motors prove their durable quality on millions of appliances.

But there's another important reason why so many manufacturers prefer to deal with Delco. Today's fast-changing markets often necessitate equally fast changes in motor specifications or delivery dates. Delco has the facilities and know-how to accommodate these revisions . . . to deliver what is needed on time—all the time.

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DELCO MOTORS

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Division of General Motors Corporation, Dayton, Ohio

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DESIGN MEN SPECIFY CARAVAN axles because they increase operating efficiency, provide dependable movability and reduce axle costs.

CARAVAN AXLES are recommended for utilization with military and industrial as well as field service and construction equipment such as concrete mixers, welding apparatus, drilling rigs, fire fighting apparatus, etc.

CARAVAN units can be furnished in two-wheel, single-axle assemblies as well as four wheel running gear equipped with automotive type steering mechanisms. Straight and drop-axle type construction can be supplied as standard.

Employing controlled camber, toe-in and caster, which facilitate positive trail at high speeds, CARAVAN AXLES provide smooth steady movability over high grade surfaces and maximum roadability over rough terrain. Axle beam construction is of solid square steel stock and sized to individual specifications.

CARAVAN AXLES are available having load capacities ranging from 1000 to more than 12,000 pounds, and they can be furnished in a wide range of sizes and models to meet all requirements.

Write today for your copy of UNITED'S new 12-page, multi-colored and illustrated Catalog No. 101 which describes CARAVAN axles as well as CARAVAN surge-control braking device and CARAVAN retractable third-wheel for use with two-wheel single-axle units. Catalog includes photographs, line drawings and complete specifications.

225-UM

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Specify THERMALLOY* for heat and abrasion resistance . . . CHEMALLOY* for corrosion resistance

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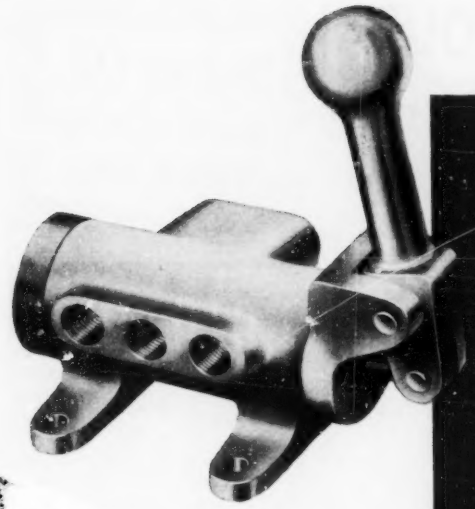
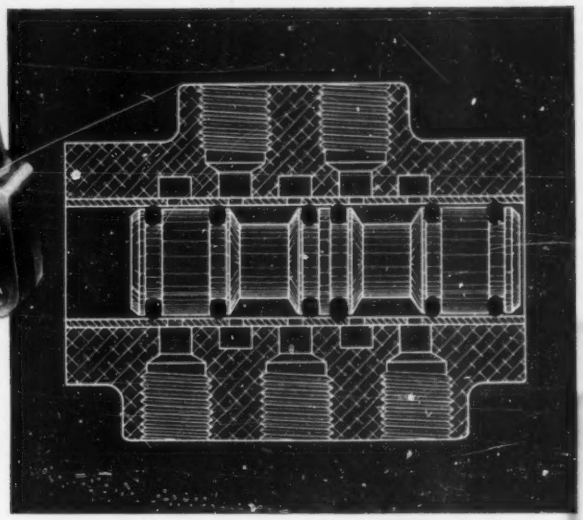
AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

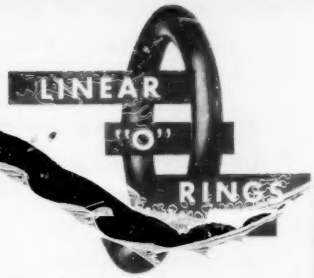




TIP...

FOR DESIGNERS

Forty Million Cycles Without Wear Using



Think of it! Forty million cycles—*eighty* million strokes—and still no sign of wear in a Modernair CV Series pilot valve using six Linear "O" Rings as a sliding seal between cylinder and piston.

This was no laboratory set-up. This example of outstanding service from Linear "O" Rings was reported by the Victor Equipment Company, users of Modernair control valves.

Trouble-free service measured in scores of millions of cycles is only one advantage credited to Linear "O" Rings. When wear finally does become evident, the valve is *completely renewed* simply by installing new Linear "O" Rings. Elimination of metal-to-metal contact makes possible the use of easily machined aluminum instead of cast iron or steel. This means low fabricating costs and light, compact construction.

Linear "O" Rings are compounded of natural or synthetic rubber, fluorethylene polymers, and "Silastics" . . . are molded in a complete range of J.I.C. and A.N. standard sizes, as well as hundreds of non-standard sizes and special shapes. Precision molded under rigid laboratory control, Linear "O" Rings may be depended upon for continuous and lasting service.

It will pay you to consult Linear during the design stages of your sealing applications.

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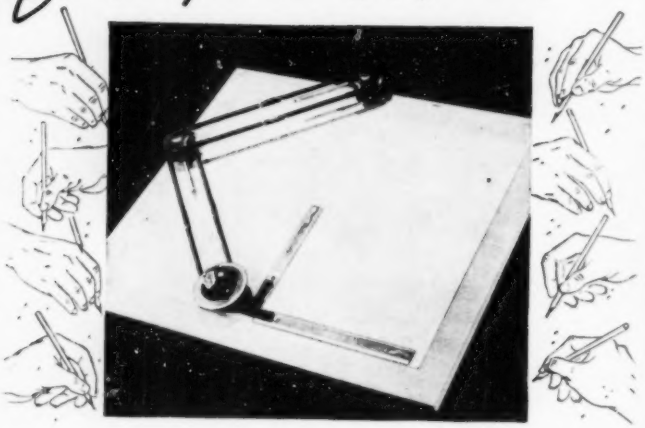

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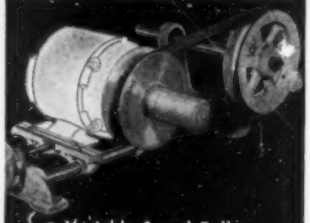
Complete VARIABLE SPEED DRIVES



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- V-Belts
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Here's the "Why" of Roto-Cone's Superiority...

V to V DRIVE
sizes ⅓ to 15 h.p.

UP TO 4 to 1
Speed-Change Ratio

Straight Line
Base Adjustment

Here is Industry's most versatile speed control drive. Rack and pinion arrangement, *exclusive* in Roto-Cone, provides equal and opposite lateral movement of both discs, therefore V-belt *always* travels on a fixed center line. Result is maximum, vibrationless transmission of power and full belt life. No expensive angular base mounting required.

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SELF-SEALING COUPLINGS

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The NEW *Improved* series of HILLIARD *Slip Clutches*

★ PROTECT YOUR MACHINERY FROM DESTRUCTIVE OVER-LOAD

★ IMPROVE THE CONTROL OF YOUR REWIND STAND

REGULAR SERIES—From 50 inch lbs. to 300,000 inch lbs. torque. Prevents transmission of overload. Constant torque clutches can be pre-set.

NOW AVAILABLE — Adjustable while running constant tension clutches. Provide ample friction surface for heavy duty use in reeling and winding operations.

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101 West Fourth Street — Elmira, New York

Textile processors will recognize this unique belt as part of a Bale Breaker . . . the device that rips apart bales of raw fibre for processing. Heretofore, it has consisted of a series of steel spikes mounted on canvas belting. However, the spikes often strike stones, bits of metal or other foreign objects inside the bale, causing sparks that ignite flash fires that burn the belt itself.

Cambridge design engineers solved this problem by attaching metal spikes to a standard *woven wire* conveyor belt. Results: fewer fires because Monel metal spikes reduce sparking, no belt damage or repairs when fires do occur, water from sprinklers will not harm the belt, longer belt life from all-metal construction.

This is a typical example of the many unusual or difficult problems solved by the use of Cambridge woven wire conveyor belts. Cambridge belts can be constructed from any metal or alloy in a wide range of open or closed weaves. For any problem of combining product movement with processing through heat, cold or corrosive agents, rely on the experienced advice of your Cambridge Field Engineer. Write direct or see "Belting-Mechanical" in your Classified Telephone Directory.

The Cambridge Wire Cloth Co.

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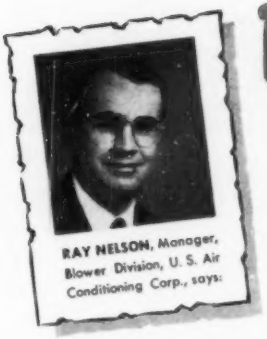
See us at the Metal Show BOOTH C-111

OFFICES IN PRINCIPAL INDUSTRIAL CITIES

FREE CATALOG gives belt specifications, construction features, engineering data and conveyor design for many plants including food, ceramic, chemical, metalworking and others. **WRITE TODAY FOR YOUR COPY** of this valuable reference.



RAY NELSON, Manager, Blower Division, U. S. Air Conditioning Corp., says:

Durkee-Atwood V-Belts solved our Vibration problem

"In designing our Type CH Ventilating Sets, we found heavy vibration in test models . . . and traced the trouble to the short-center V-drive. When we called in Durkee-Atwood engineers, they showed us that the vibration was caused by the multiple belts. Durkee-Atwood solved this problem by vibration-testing their standard belts on their special equipment to meet our requirements. These belts, perfectly matched and with uniform cross sections, completely eliminated vibration. They run so true that *we have not had a single complaint from the field* on the performance of this ventilating set."

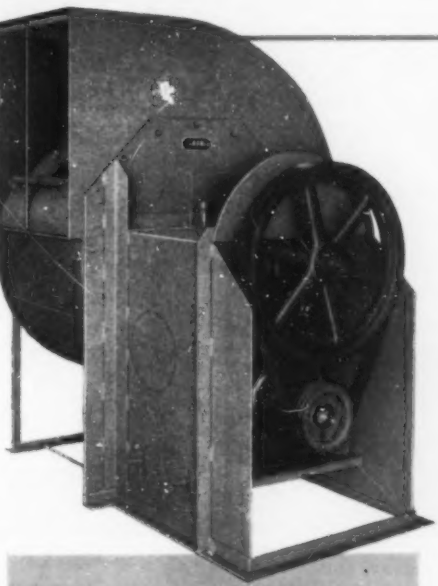
WHAT'S *YOUR* V-BELT DESIGN PROBLEM?

Vibration? A "different" V-drive? Then give Durkee-Atwood a chance to help engineer the design! Durkee-Atwood is a medium-sized company, so we can give exacting attention to every belt order. With our special testing equipment, we assure absolute matching of multiple belts . . . make sure that cross sections are perfectly uniform. This means *vibration-free* transmission for you . . . smoother operation and longer lasting service for your products.

Our moderate size permits fluid production, too—special work and emergency orders. Yet D-A's six modern plants and up-to-date equipment can handle your biggest orders!

If your current project calls for a unique V-drive—a "mule drive" for example, or a drive using sheaves smaller than recommended minimums—experienced Durkee-Atwood engineers are at your service. They will help you meet your special OEM requirements . . . help you get the results you want.

In our 30 years in business, we have established a record for quality V-belts. That is why we can *guarantee* the life of every Durkee-Atwood V-Belt! Write for complete details—or ask your nearest Durkee-Atwood distributor.



usAIRco Type CH Housed Ventilating Sets. For efficient, low-cost ventilation application . . . for factories, laboratories, hotels, restaurants, hospitals. Compact, weather-proof design for inside or outdoor application. Capacities from 500 cfm to 18,000 cfm.

V-DRIVE ENGINEERING DATA— WRITE FOR FREE COPY

DURKEE ATWOOD V-BELTS

Form No. 522

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Maybe it all *does* look pretty much the same at first glance. But when a firm has been making wire mesh for 70 years man and boy, there's bound to be a little more to it than meets the eye—a little more know-how in engineering and weaving, a little more quality in the product, a little more service and satisfaction for the user.

JELLIFF WIRE MESH is woven in all ductile metals
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JELLIFF WIRE MESH is economical. Every foot runs true to the specifications.

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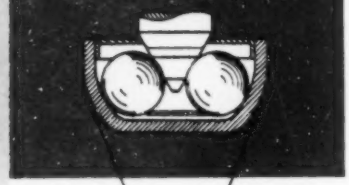

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Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

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Write for Bulletin 500

Ledeen Mfg. Co.
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Add salability to your product!

Equip each motor or engine with a Mercury Automatic Clutch for easier starting and smoother operation.

An electric motor equipped with a Mercury Automatic Clutch starts easily and picks up the load smoothly.

Starting current is reduced and the motor reaches full speed before the load is applied. Stalling is eliminated, thus preventing burned out wiring, blown fuses and fire hazards.

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These are the sort of talking points which add salability to your product.

Mercury Clutches are available for electric motors and gas engines up to 25 H.P. ratings. Write for catalog PA-5.

MERCURY CLUTCH DIVISION
AUTOMATIC STEEL PRODUCTS, INC.
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ONE WASHER INSTEAD OF TWO WITH WEATHERSEAL!

The Weatherseal Washer combines a metal and a compressive, sealing washer, hydraulically bonded and "cured" together to provide just one piece to handle. The compressive material is composition rubber or neoprene, and it does a real job of sealing as this actual cutaway photo shows:

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Note that the neoprene is extruded under compression to completely seal the outer edge of the metal washer as well as the fastener shank, through the metal sheets to the nut.

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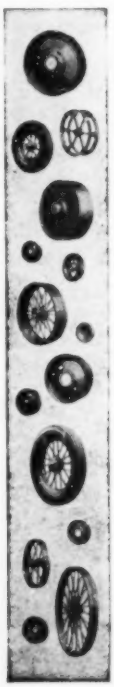

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WHEELS ARE RIGHT

Over 65 years in wheel manufacturing have given us the "know how"—modern production methods assure long life and efficient wheel performance in the field.

There is an ELECTRIC spoke or disc wheel for most types of portable equipment. Axles are available where required.

Our experienced engineers are ready to assist you in solving your wheel and axle problems and we will offer our recommendations upon receipt of your specifications.

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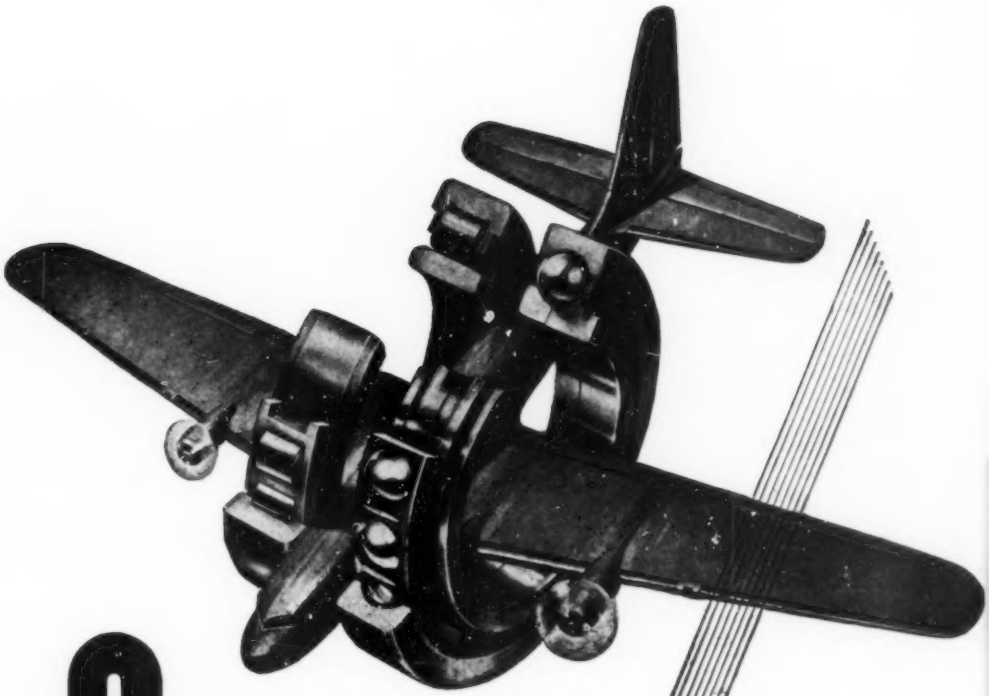


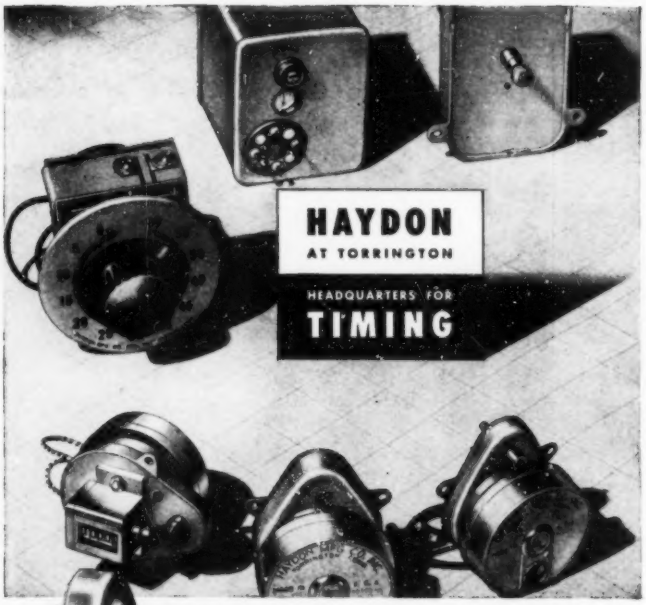
9/10

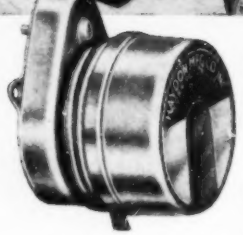
The engine manufacturers who produce approximately nine-tenths* of the power for AMERICA'S aircraft use SKF BEARINGS.

This, again, is typical of the acceptance of SKF Bearings by *all* industry—acceptance which has been built on confidence in SKF's ability to help industry put the right bearing in the right place. 7165

SKF
BALL AND ROLLER BEARINGS

SKF INDUSTRIES, INC., PHILADELPHIA 32, PENNA.
-manufacturers of SKF and HESS-BRIGHT Bearings.





400 Cycle Motor

SYNCHRONOUS TIMING MOTORS and TIMERS for

- *Industrial*
- *Military*
- *Commercial Uses*

HAYDON* research and engineering staffs constantly seek to develop new and build better products. One example is the HAYDON 400 cycle timing motor. This is an hysteresis type synchronous timing motor, for use as a separate motor or in many different types of timers. HAYDON personnel and plant are equipped to build motors and timers using D.C., 60 cycle or 400 cycle for military or civilian applications.

HAYDON manufactures a wide range of dependable timing motors notable for their small size; quiet operation; total enclosure; separate systems for controlled lubrication of rotor and gear train; ability to operate in any position. Standard speed range from 60 rpm to one revolution in 7 days. The HAYDON motor is the basic element for standard timing components and custom-engineered timers designed and manufactured by the company for volume applications.

DESIGN INFORMATION

HAYDON will gladly send you technical data on request.

*TRADEMARK REG. U. S. PAT. OFFICE

HAYDON Manufacturing Co., Inc.

Subsidiary of GENERAL TIME CORPORATION

3134 ELM STREET

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Help Lower Unit Production Cost to Meet Competition

Profitably . . .

Simplified screw driving, bolt setting and nut running mean lower unit cost. This is possible with Pheoll products because they are inspected through all manufacturing steps from coil wire or bar stock to the finished product.

All threads, whether rolled or cut, are carefully gauged to American Standards. Screw and bolt heads are formed, slotted or recessed to meet rigid engineering requirements. Overall quality of the finished product is uniformly high. Precision head formation on all bolts as well as engineered slots and recesses in all screws means less wrench and driver slippage.

Pheoll engineers will recommend the correct type, size and finish of standard or special screws, bolts and nuts for your needs.

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- Simpler and speedier assemblies.
- Less worker fatigue — more units.
- Improved product appearance.
- Added latitude in product design.
- Immediate and dependable source for standardized, interchangeable screws, bolts and nuts especially suited to mass production.

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- Sems
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- Square Head Set Screws
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- Cap Screws
- Phillips Recessed Head Screws
- Machine Bolts
- Wing Nuts
- Knurled Nuts

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Pheoll

MANUFACTURING COMPANY

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SCREWS • BOLTS • NUTS

NEW — a low-cost* whiteprinter

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Here's the new Bruning Model 20 Copyflex. Because of its low price, thousands of companies now can make their own whiteprints and thus realize a substantial saving. Now you can produce your whiteprints *when* you want them — as you want them.

It will pay for itself by producing sharp, clean prints of your engineering drawings as well as copying your production orders, reports, specifications, defense order copies, etc.

The Model 20 is a completely new, medium volume machine of advanced design, yet sells for the lowest price of any machine in its class. It has a full 46" printing width, and takes cut or roll stock.

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- **EASY OPERATION.** No training needed — anyone can operate a Copyflex.

See how the Model 20 Copyflex, or one of our other models, can help you. There is a model for every price and volume requirement. Clip the coupon now and you'll be on the road to faster, less expensive copying.

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☐ Send me full details on the Model 20 Copyflex.

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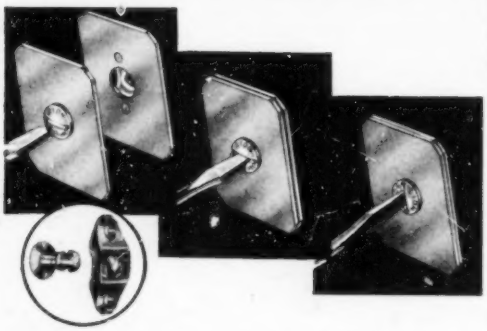
For Parts that must be

TAKEN OFF—PUT BACK—BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN

Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

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Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

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High production demands rugged components that can "take it." Cullman Sprockets and Roller Chain best meet today's demands because they are far beyond minimum standard of precision. Strict adherence to specifications insures Cullman uniformity.

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Hardened sprocket teeth engaging double-strand chain make Cullman Flexible Couplings outstandingly rugged components. They insure long service in a large variety of applications—represent a very efficient method of connecting two shafts of equal or different diameters.

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This new time-saving hub sprocket is already in great demand. Installs easily without alterations. Ratio changes quickly made at minimum cost. Sprockets can be interchanged and mounted without removing hubs from shaft. Hubs available with bores for most requirements.

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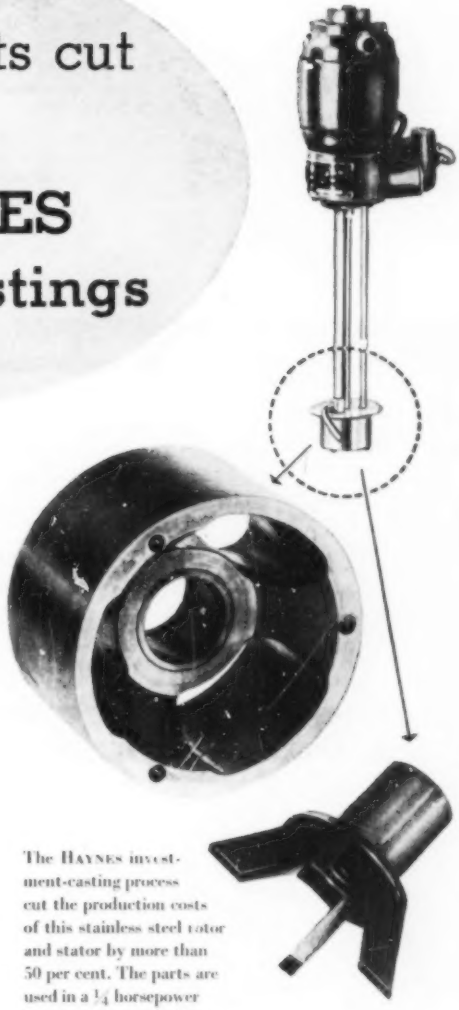
Production costs cut over 50% with HAYNES Trade-Mark investment castings



A manufacturer of homogenizing equipment is producing stainless steel rotors and stators at half the former cost, now that he has switched from machined parts to precision investment castings. Machined parts required a total of 12 operations before they were ready for service. HAYNES investment castings require only 5 finishing operations.

The production saving on the rotor, or turbine, is 52 per cent, even though the investment-cast part costs about 6 times more that the bar stock needed for a machined part. This is because only 2 finishing operations are needed for the castings, whereas 5 operations were necessary when the parts were machined from bar stock.

The stator required 7 machining operations originally, and now requires only 3 — one of which is an electro-polishing treatment. By changing over to investment castings, the manufacturer has cut his production costs on this part 51 per cent.

A large assortment of investment castings and other HAYNES alloy products will be on display in Area F-440 at the National Metals Exposition in Detroit, October 15 to 19. Be sure to stop in.

The HAYNES investment-casting process cut the production costs of this stainless steel rotor and stator by more than 50 per cent. The parts are used in a ¼ horsepower homogenizing machine.

HAYNES TRADE-MARK alloys

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
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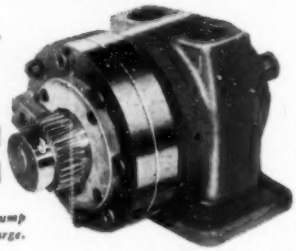
Oil Flow During Operation

NO VALVES . . . NO CHANGE IN SPEED OR DIRECTION OF ROTATION



(Right) Standard control pump mounted for vertical discharge.

This vane-type hydraulic pump provides positive displacement . . . but allows instant regulation of the volume and direction of oil flow to fit your individual circuit or cycle conditions. With the motor and pump operating continuously in one direction, you can:

1. Adjust the oil volume delivered to suit the job.
2. Vary the oil volume delivered at any part of the cycle.
3. Reverse the oil flow.
4. Completely stop the oil flow.

A small movement of the control will change the displacement of the pump or the direction of the discharge. This control may be used either as a simple volume adjustment or as an integral part of a cycle control system. Manual, automatic and remote control means are available. Ideal for hydraulic motor drives.

NO SPRINGS—NO VANE WEAR

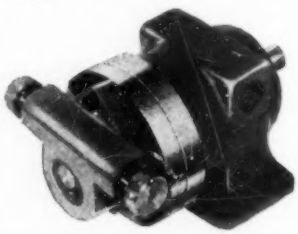
Vanes are positioned mechanically—no springs are employed. The pressure ring which contacts the vane tips rotates with the vanes, reducing friction and wear.

The *HYDROPUMP* is available in foot mounted, flange mounted and stripped models. Multiple ports and methods of mounting provide 16 possible connection combinations. Capacity 0 to 10 g.p.m. in either direction.

WRITE FOR ENGINEERING HELP AND LITERATURE

Ask for Bulletin 100-P. Submit your problems for recommendations. No obligation.

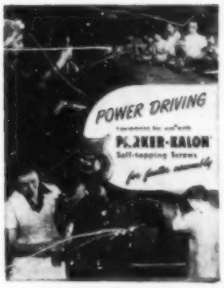
(Below) HYDROPUMP with micrometer volume control, mounted for horizontal discharge.



MILWAUKEE HYDROPOWER
INC.

3445 N. 35th St. Milwaukee 16, Wis.

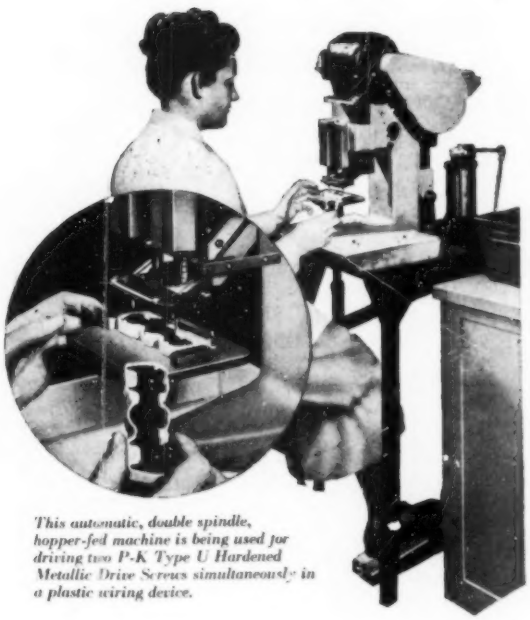
NEW P-K Bulletin tells how to add more speed to the faster fastening method



Describes and illustrates the various basic types of electric, air-operated and impact tools, as well as the automatic hopper-fed machines for screw driving in common use. Helps you determine which type is best for your assemblies. Also includes useful information on proper bit and socket selection. Free on request.

POWER DRIVING

of P-K Self-tapping Screws



This automatic, double spindle, hopper-fed machine is being used for driving two P-K Type U Hardened Metallic Drive Screws simultaneously in a plastic wiring device.

To meet America's colossal production requirements . . . for defense, for civilian goods . . . even more speed is needed in operations that have already set time-saving records.

Fitting right into this urgent need for *more speed, more efficiency*—in assembly operations—is the ever-wider use of Power Driving devices with P-K Screws.

A wide range of Power Driving equipment is available for use with the various types of P-K fasteners—and with slotted, Phillips recessed, and hex head styles. And all types have this in common—a substantial reduction in assembly time and cost.

Parker-Kalon does not manufacture power-driving equipment, but has tested many devices in the P-K laboratory under production line conditions, and found them suitable for use with P-K Screws. The information contained in the "Power Driving" Bulletin is based on reports of these many tests.

For specific information on power driving applied to your assemblies, talk to a P-K Assembly Engineer. Your P-K Distributor will furnish a copy of the Power Driving Bulletin . . . ask for Form No. 491. Or write: Parker-Kalon Corporation, 200 Varick St., New York 14.

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The surest way to realize the full economies inherent in the die casting process is *early* consultation with a competent die casting engineer—*before the design has advanced so far that changes are impossible or impractical.* Any die casting company will be glad to have an engineer help you in adapting the design of a part to its most economical production by the die casting process.

VISIT BOOTH A 162 AT THE METAL SHOW

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

USE OUR BOOKLETS . . .

To help prospective die casting purchasers, The New Jersey Zinc Company has prepared booklets giving up-to-date information on ZINC Die Castings. These booklets cover alloys, design, machining, finishing and applications. We will be glad to send copies of any of these booklets to you—or they may be obtained through any die casting company.

SEE OUR EXHIBIT AT THE METAL SHOW . . .

Each year The New Jersey Zinc Company, on behalf of the die casting industry, assembles a comprehensive exhibit of ZINC Die Castings at the National Metal Exposition. If you are planning to attend this year's Exposition in Detroit—October 15 to 19—be sure to visit with us in Booth A 162 (Building "A"). Here is your opportunity to see many examples of the best in die casting design and to learn—first hand—how to get the most for your ZINC Die Casting dollar!

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FOR DIE CASTING ALLOYS

The Research was done, the Alloys were developed, and most Die Castings are based on
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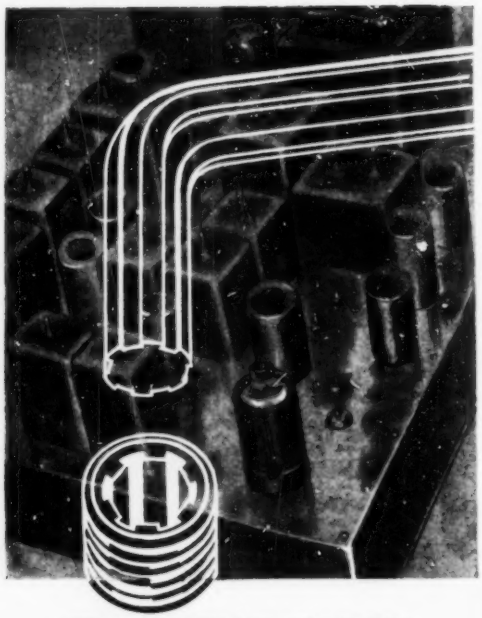

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for a tighter fastener

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They *hold* tighter . . . because they can be *tightened* tighter.

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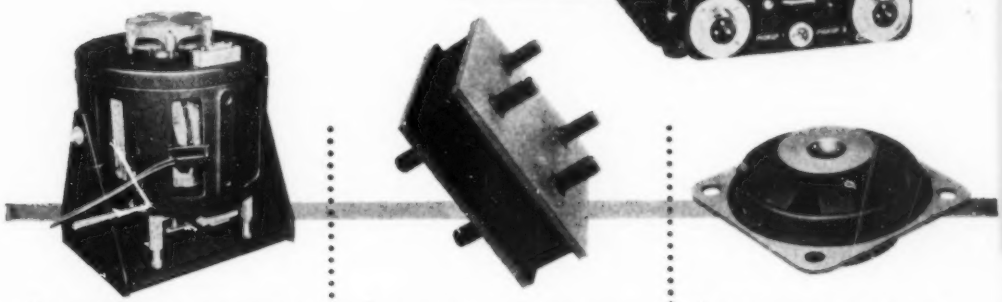
1. MEASUREMENT of vibration with MB vibration pickup and meter supplies data for study of disturbing frequencies and for design adjustments. The electrically damped and highly sensitive pickup is convertible for horizontal or vertical operation. Meter gives you accelerations, velocities or displacements of the vibrations directly. Made for each other, the two are the "eyes" for any vibration testing program.



2. SHAKE TESTING TO MIL-E-5272 and 41065-B is easily accomplished with MB Vibration Exciters. Model S-3 shown delivers 200-lb force. Others available with 10-lbs to 2500-lbs force ratings—all easily, quickly and accurately controlled for force and frequency.

3. ISOMODE* SHOCK MOUNTS have been developed for supporting and protecting aircraft engines from damage while transported in crates or "cans." High load capacity combined with high deflection capacity provides good absorption of shock. **Reg. U.S. Pat. Off.*

4. MIL-I-5432 (AN-I-16a) can be met with the Type 17 ISOMODE Mount. This unit available for loads from 0.5 to 100 pounds, and controls all modes of vibration with equal efficiency because of equal spring rate in all directions.

Remember, if you need help with a vibration problem, you can save yourself time and work by contacting MB's vibration specialists. For details on any of the above products, address your inquiry to Dept. N6.

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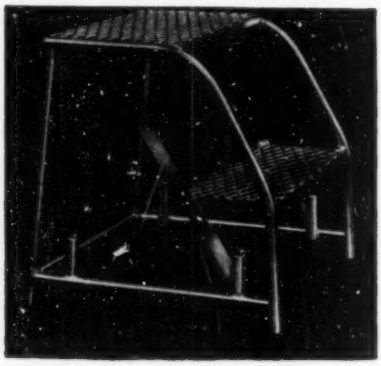

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The rugged 1½" mesh is being used for heavy duty jobs. The dainty, almost jewel-like 3/16" mesh is used for ornamental grilles such as for radio and TV. For sizes between there are hundreds of proven uses, with new ones developing every day.

Expanded Metal is used extensively today, and promises to be increasingly in demand in the future. Architects, engineers and designers are finding new applications constantly. Everywhere that strength without bulk is desired, where substantial saving in critical metals is essential, where reduction in weight is important, where the passage of light and air is wanted, where decorative effects are sought, there is a place for PENMETAL Expanded Metal.

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82nd PENMETAL YEAR

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MORTON

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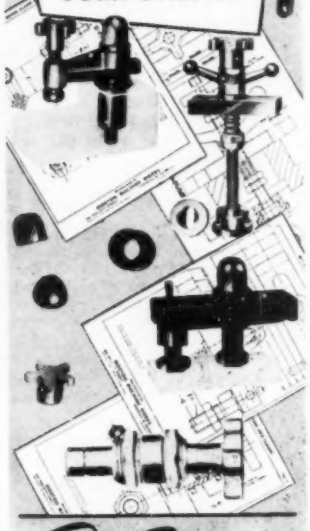

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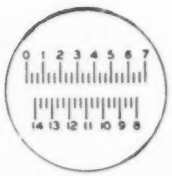

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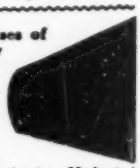
Engineering data on the design of ultrasonic systems

Considers the many uses of ultrasonics in industry



HERE is the first engineering consideration of the ultrasonic field . . . the essential theory, plus an abundance of practical information never before published! This important new book reviews electronic considerations and outlines of circuits. Mechanical and electrical design and construction techniques of ultrasonic systems are included . . . everything from the design considerations of holders for ultrasonic use to the experimental measurement of ultrasonic waves in various media.

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Formerly, Product Research Supervisor, Sperry Products

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BOTH theoretical and practical, this book is definitely slanted toward engineering design and use in definite industrial applications. It brings you valuable information on: material testing, agitation, ultrasonic transducers, ultrasonic systems. It explains clearly the characteristics of ultrasonic waves that are important in practical applications: curves, waves, and complex waves; Fourier's theorem, wave trains and the law of angular transmission; the ways ultrasonic waves may be produced, and the electro-mechanical converting systems.

Evaluates Practical Uses in Many Fields

Brought out of the research laboratory and into industry, ultrasonics has tremendously broad, practical applications. This guide points the way to greater use of ultrasonics in, for example, MATERIALS TESTING: to detect flaws in metals, plastics and glass, etc.; CHEMICAL INDUSTRIES: to make better mixtures and emulsions, etc.; METALURGY: for extremely uniform mixtures free of air bubbles, etc. It likewise discusses experimental applications to systems of television, underwater signaling, depth sounding, communication, destruction of bacteria, etc.

CONTENTS

1. Ultrasonic Waves
2. Ultrasonic Waves: Further Theory
3. Crystals for Ultrasonic Use
4. Crystal Holders for Ultrasonic Use
5. Resonance and Reflection
6. Continuous-wave Ultrasonic Systems
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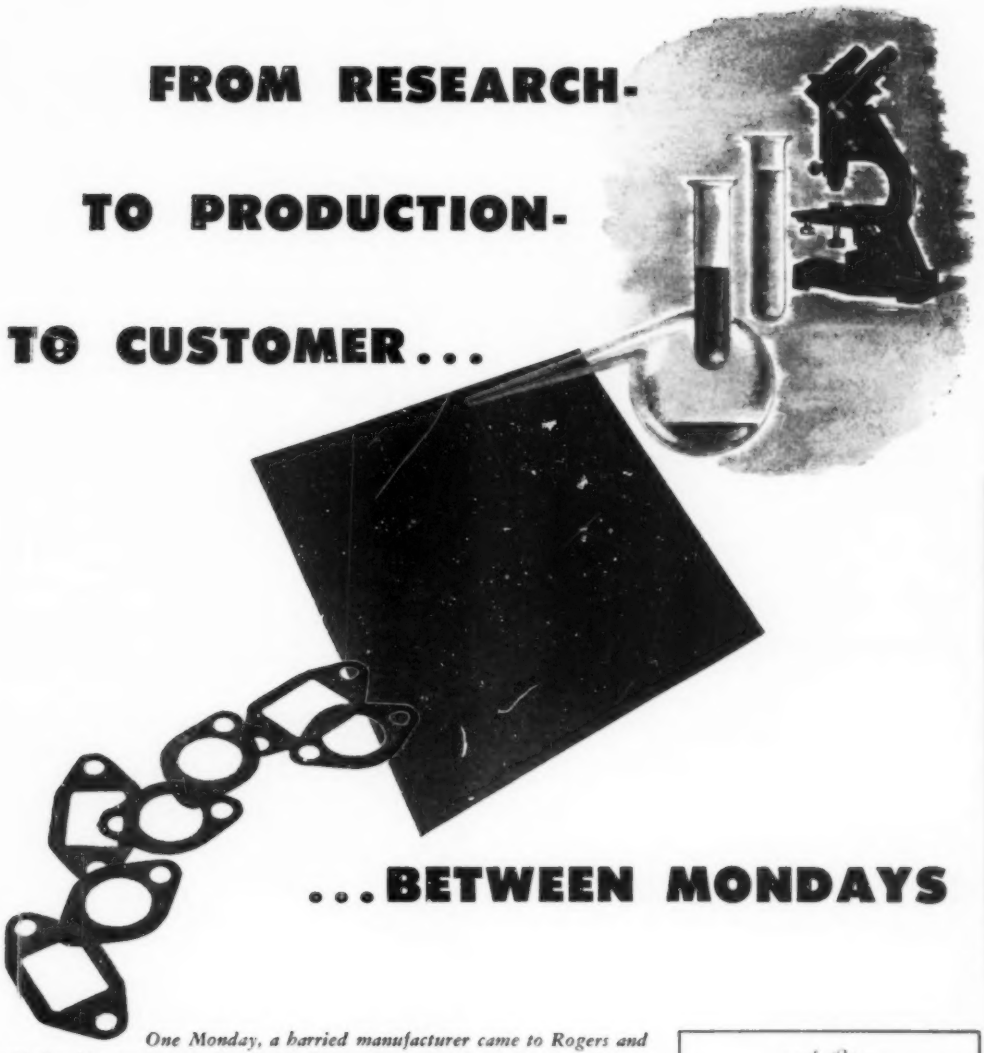

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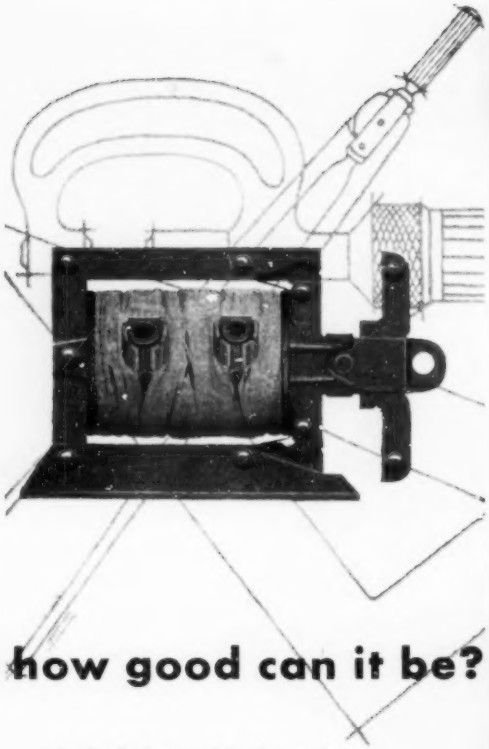

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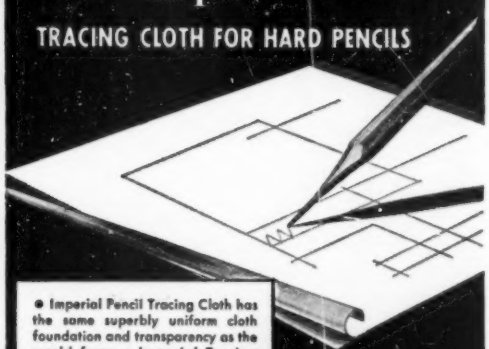

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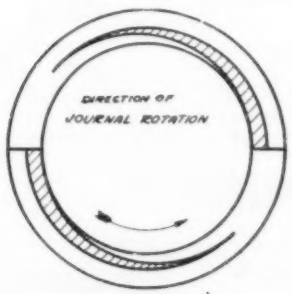
Flanged Sleeve Bearings

THE addition of a flange on a sleeve bearing often serves as a very useful device to the designer. For instance it is an ideal way of meeting the problem of end thrust. Or it can serve to locate or anchor the bearing; to act as a divider; or to form a recess to hold the lubricant. In some cases, particularly in electric motor bearings, the flange has a beveled edge to insure alignment.

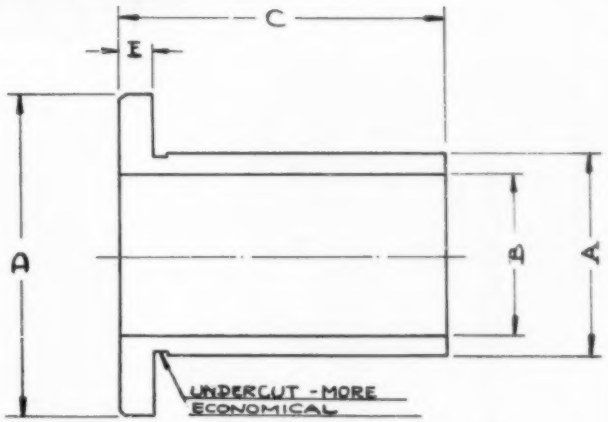
In cast bronze bearings the flange can be located anywhere on the outside diameter and can be made any thickness as required. In sheet metal bearings the location of the flange is limited to the ends and cannot be any thicker than the metal used in the body of the bearing.

In applications where the principal use of a flange is to meet a thrust condition it is well to include oil grooves on the face of the flange. In cast bronze the most popular type is the wedge shape as illustrated herewith. This permits the introduction of oil in order to produce the hydraulic pressure required to separate the flat surfaces. Sheet metal bearings usually employ a design known as "tear drop."

In applications where the operating speed is comparatively slow, it is often wise to use graphite impregnated bearings. The graphite can be included on both the inside diameter and the flange of the bearing. In some cases it is often difficult or impossible to locate the oil intake in the proper place to insure good lubrication while at the same time make it convenient and accessible. The use of flange in applications of this nature provides a reservoir for the lubricant. The oil intake can be placed in the most convenient place on the housing while the corresponding hole in the bearing can be placed where operating conditions demand.



Recommended type of groove on face of flange.



Measurements to specify when ordering Flanged Bearings.

Powder Metallurgy

When the application permits, the most economical method of producing flanged bearings is by Johnson LEDALOYL. With this method the complete bearing is formed, under pressure, to required size and tolerance. All machine work is eliminated and you gain the advantage of the self-lubricating action. Many sizes of LEDALOYL flanged bearings are standard stock items, ready for immediate delivery. Our new catalogue gives a complete listing of sizes available. Write for your copy.

How to order Flanged Bearings

When ordering or specifying flanged bearing it is important that *all* dimensions are given. This diagram can be used as a guide. When using flanged half bearings be sure to specify whether they are FULL halves or SAW CUT. Saw Cut bearings can be used where shims are included. Full cut bearings are more expensive but are necessary for precision fits. The use of an undercut under the flange lowers production costs but does not interfere with the efficient operation of the bearing.

A. Outside diameter of bearing.
B. Inside diameter of bearing.
C. Length—over-all—of bearing.
D. Outside diameter of flange.
E. Thickness of Flange.

Engineering Service

Johnson Bronze offers manufacturers of all types of equipment a complete engineering and metallurgical service. We can help you determine the exact type of bearing that will give you the greatest amount of service for the longest period of time. We can show you how to design your bearings so that they can be produced in the most economical manner. As we manufacture all types of Sleeve Bearings, we base all of our recommendations on facts free from prejudice. Why not take full advantage of this free service?

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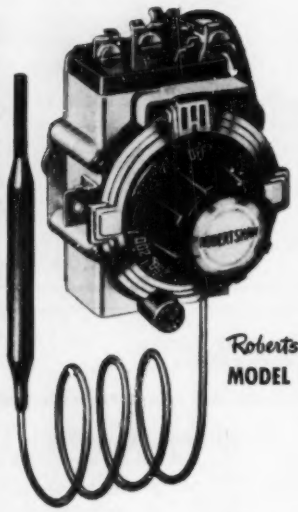

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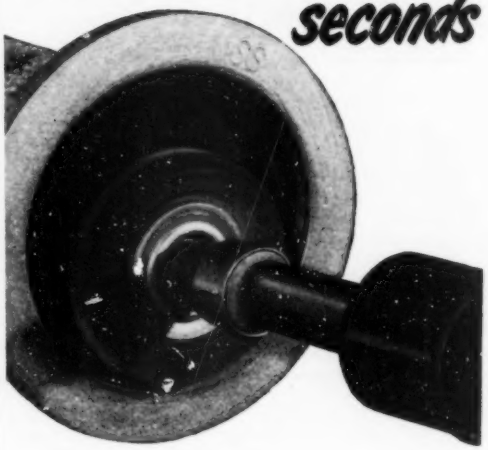

** An actual case history from the U. S. Pipe and Foundry Company, Birmingham, Alabama*

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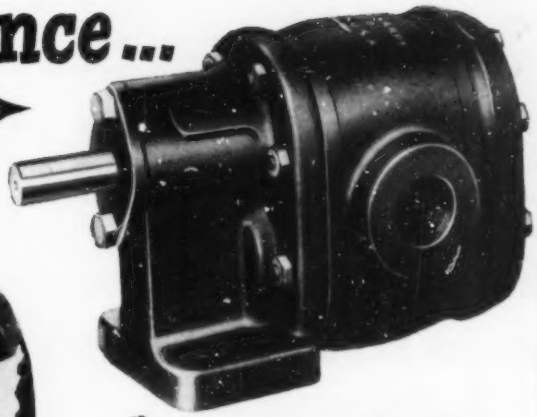

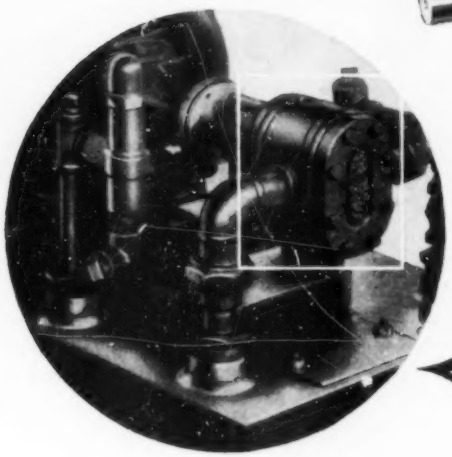

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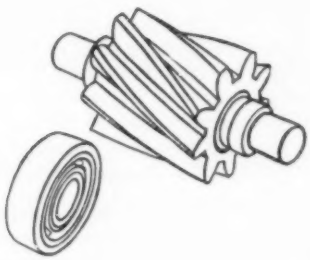
with Helical Gears and Roller Bearings



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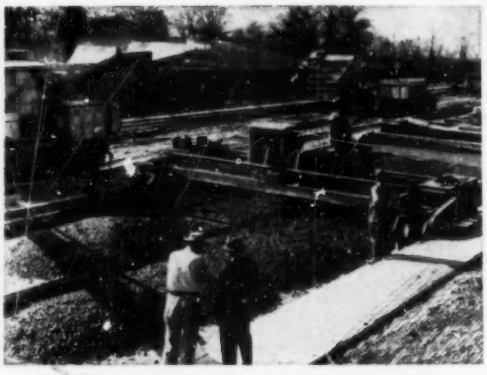

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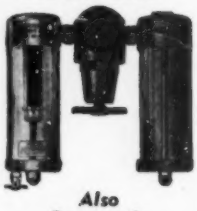

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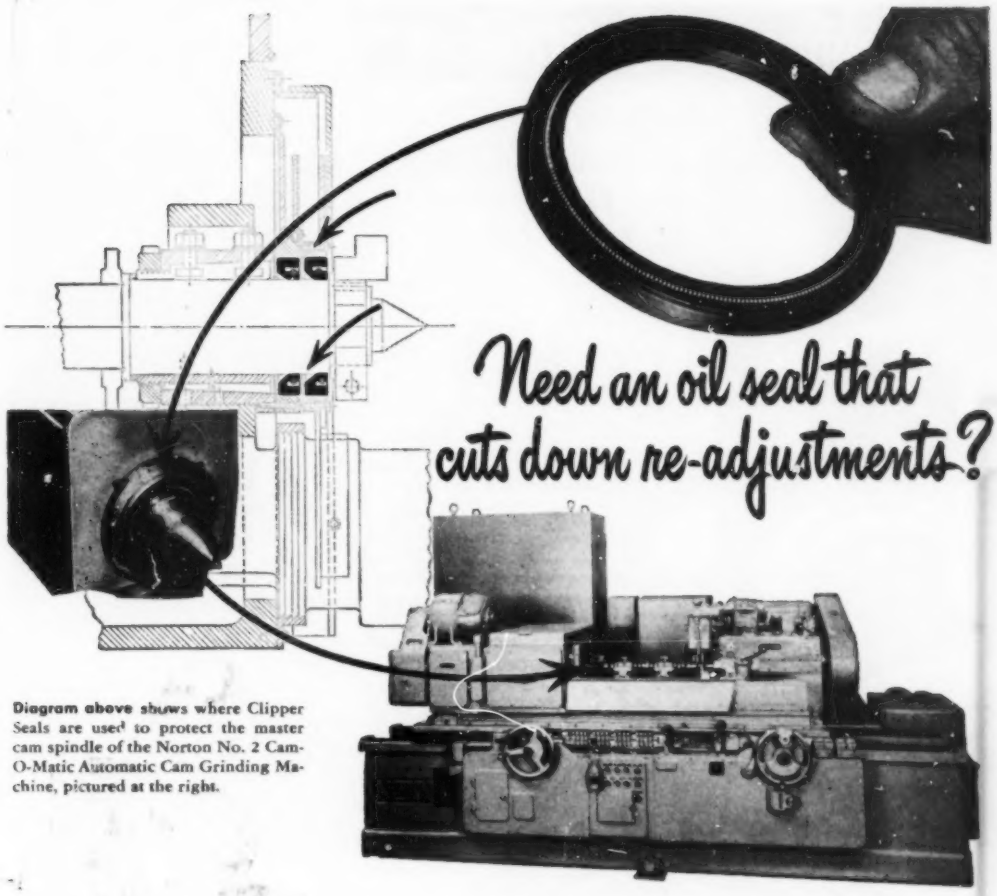

Need an oil seal that cuts down re-adjustments?

Diagram above shows where Clipper Seals are used to protect the master cam spindle of the Norton No. 2 Cam-O-Matic Automatic Cam Grinding Machine, pictured at the right.

Norton Company found the answer in Clipper Seals

In designing their No. 2 Cam-O-Matic Automatic Cam Grinding Machine, Norton Company engineers faced the problem of selecting an oil seal that could be depended on to seal lubricant in and keep foreign matter out *without overheating* . . . thereby help maintain accurate settings *and cut down re-adjustments.*

Clipper Seals—because they are precision-made, tough, and compact—proved to be exactly the highly efficient, cool-running oil seal that was needed.

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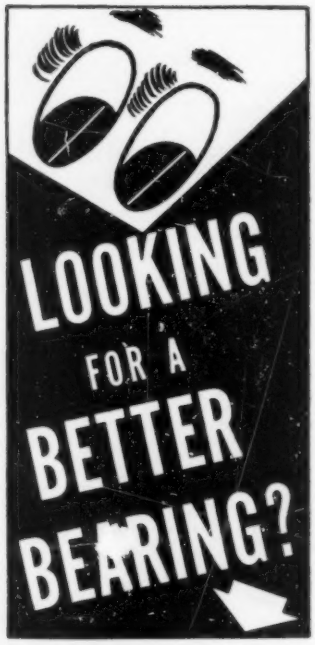

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Solid, hard or sponge rubber parts molded to customers specifications from natural, synthetic and reclaimed rubber

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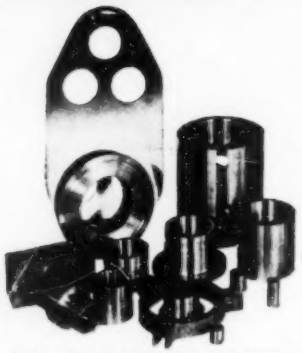

American Crucible methods, experience, know-how and equipment result in highest quality . . . bearings that carry a

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Machined or Rough Cast of the Specific Formula Best Suited to the Application.

Write for literature or send blueprints, conditions of operation, etc. for quotations and recommendations as to alloys.

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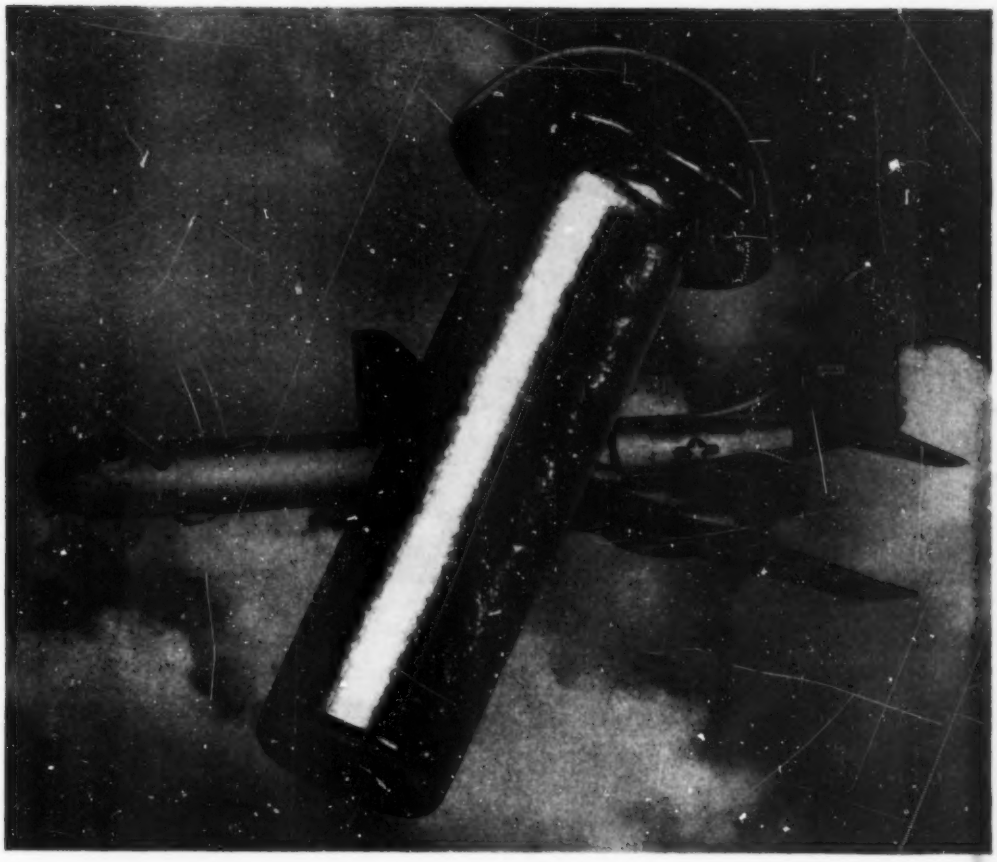

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Our Industrial Division is daily solving many of the engineer's problems for contacts, contact materials, collector rings, small fabricated parts in both precious metals and precious metal-clad as well as composite base metals. Intimately bonded alloys permit you to use the many advantages of precious metals without sacrificing the desired physical and mechanical properties of the base metals.

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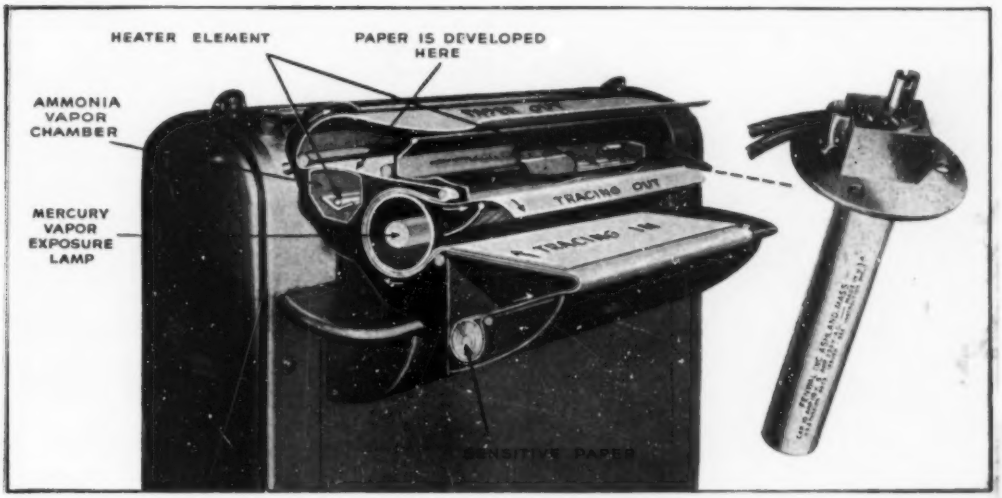

Heat control problem in Ozalid reproduction machine solved

by Multi-Purpose Thermostat

When the Ozalid Streamliner reproduction machine was designed, a vital factor toward its successful performance was the maintenance of an even temperature within the developer tank.

After sensitive paper has been exposed, it is conveyed across the perforated top of the developer tank and developed by controlled aqua ammonia vapors. These vapors are superheated by a heater within the tank. Even heating at a specified temperature is imperative as, otherwise, uneven development results.

A low-cost THERMOSWITCH thermostat olves this heat control problem. It effectively maintains the vapor at a steady temperature for optimum developing conditions, by reacting both to vapor temperature and to radiant heat from the heater.

This application is but one of many types of control problems in which easy-to-install, easy-to-maintain Fenwal THERMOSWITCH thermostats have proved successful. Their activating control element is the single-metal shell that expands or contracts *instantaneously* with temperature changes, making or breaking the totally enclosed electrical contacts. Through this unique principle, THERMOSWITCH Units effectively control *many* variables where heat is a factor.

Find out now how Fenwal THERMOSWITCH Units can help you in *your* product. Mail coupon today.

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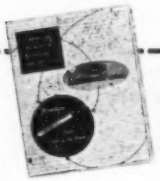
The Precision, Multi Purpose Thermostat Control

SENSITIVE . . . but only to heat



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TEMPERATURE CONTROL ENGINEERS

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I am chiefly interested in the applications checked:

- ☐ Heating
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- ☐ Vapor Level Control
- ☐ Timing (thermal)
- ☐ Radiant Heat Control
- ☐ Pressure Control (by controlling vapor temperature)

OTHER (Please fill in your special requirements) .....
.....
.....

another tough cold heading job by SCOVILL

This copper transformer stud is being produced by cold heading at Scovill for a well-known electrical manufacturing company. Note the different diameters and shapes, the staked wings and "captive" fiber washer. Copper, though difficult to work on automatic screw machines, is admirably suited for cold heading. By preserving the flow lines in the metal, cold heading also produces a stronger part.

Although this particular part is designed for an electrical component, it may spark a solution to some similar problem you have, involving different diameters, washer assembly and staked wings. For further information send your sample or blueprint.

"Guide to the Profitable Use of Cold Heading" —Bulletin No. 2 describes the advantages and limitations of this process for the designer. It's free for the asking.

RECESSED HEAD SCREWS • SEMS • TAPPING SCREWS
STANDARD MACHINE SCREWS • SPECIAL COLD HEADED PARTS

SCOVILL FASTENERS AND SPECIAL PARTS

INDUSTRIAL FASTENER SALES, WATERVILLE DIVISION
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insist on "buried" integrity in your products

In the durable goods field most of the products are composed of many component parts. Acadia Synthetic Rubbers are contributing importantly to the superiority of thousands upon thousands of these products on land, sea, and in the air—from battleships to tiny instruments. For years manufacturers in hundreds of industries have found by experience that, with Acadia Synthetic Rubber parts in their products, they will never have trouble from that source. Acadia is a "buried" but vital component for products of highest integrity. Insist upon it!

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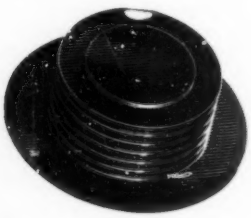

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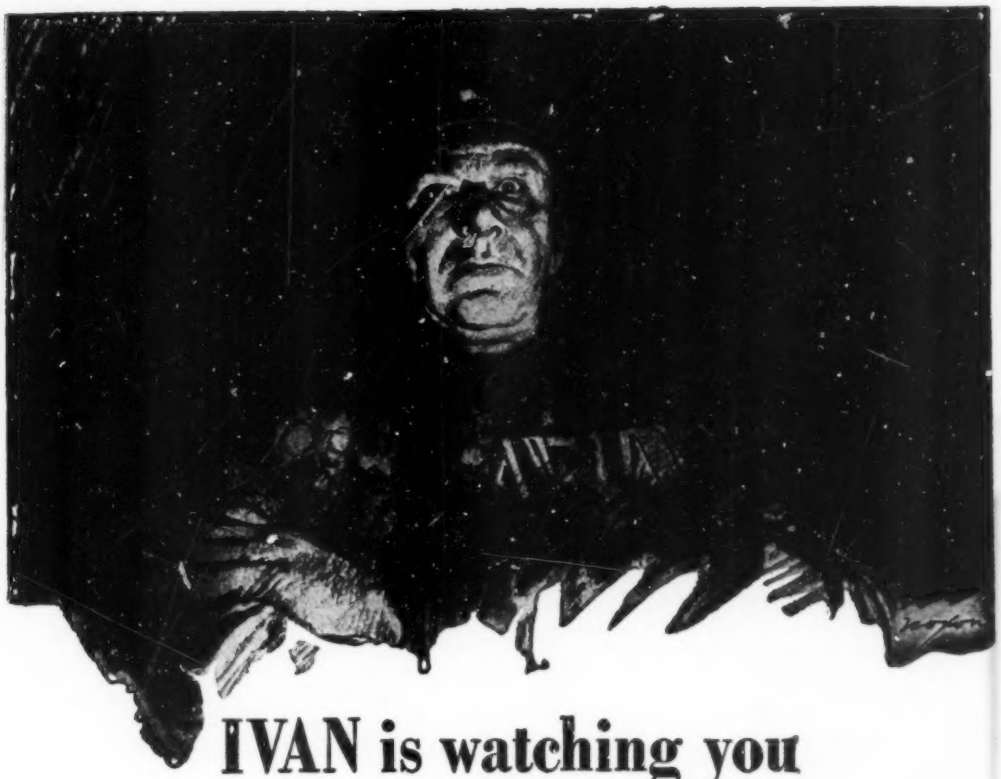

IVAN is watching you

IVAN is a dyed-in-the-wool Communist. There are only 6 million party members like him in all Russia, yet these Communist brass-hats enforce the iron dictatorship of the Kremlin over *200 million* Russians.

He's sold to the hilt on Red ideas. Which means he's out to get *you*. He believes it's either you or him . . . that the world is too small for both.

Ivan is working hard to beat you down. He has a big head start.

Right now he's got you in a bad spot.

Ivan is afraid of only one thing.

He fears your ability to out-produce him in guns, tanks, planes.

Frankly, he doesn't think you value your free system enough to do it . . . to make willingly the sacrifices he has squeezed out of the Russians.

But he's wrong!

Because you and all of us have set out to build more and better weapons—to do it faster all the time.

We must use every bit of know-how and inventive skill we have to improve our machines and methods—to turn out more and more for every hour we work. Only in this way can we become militarily strong.

But we've got to supply essential civilian needs as well. We can't allow needless shortages to take prices skyrocketing and lower the value of our dollar.

Sure, that means sacrifices for everybody. But doing this double job well is the only sure way to stop Ivan in his tracks—and to save the freedoms which are ours and which he has never known.

FREE . . . this important booklet tells you how our American System Grew Great

How Americans developed better machines, power and skills to build a great nation . . . Why we have been able to produce constantly more per hour . . . How this has given us the world's highest living standard.

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How to Plan and Control Production —for greater speed and efficiency

This guide brings you tested and improved methods of routing, scheduling, dispatching, inspecting, following-up.

PRODUCTION CONTROL

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You can get greater volume at lower cost with these successful methods of production planning and control. This guide book helps you handle more effectively your everyday problems of routing, scheduling, dispatching, inspecting, and following-up. Based on practical experience, it reflects current factory methods in more than 185 representative companies in all types of industries.

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Gives you up-to-the-minute guidance on:

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2. Organization for Control
3. Production Forecasting
4. Product Development
5. Production Analysis
6. Relating Budgeting to Production
7. Routing of Operations and Processes
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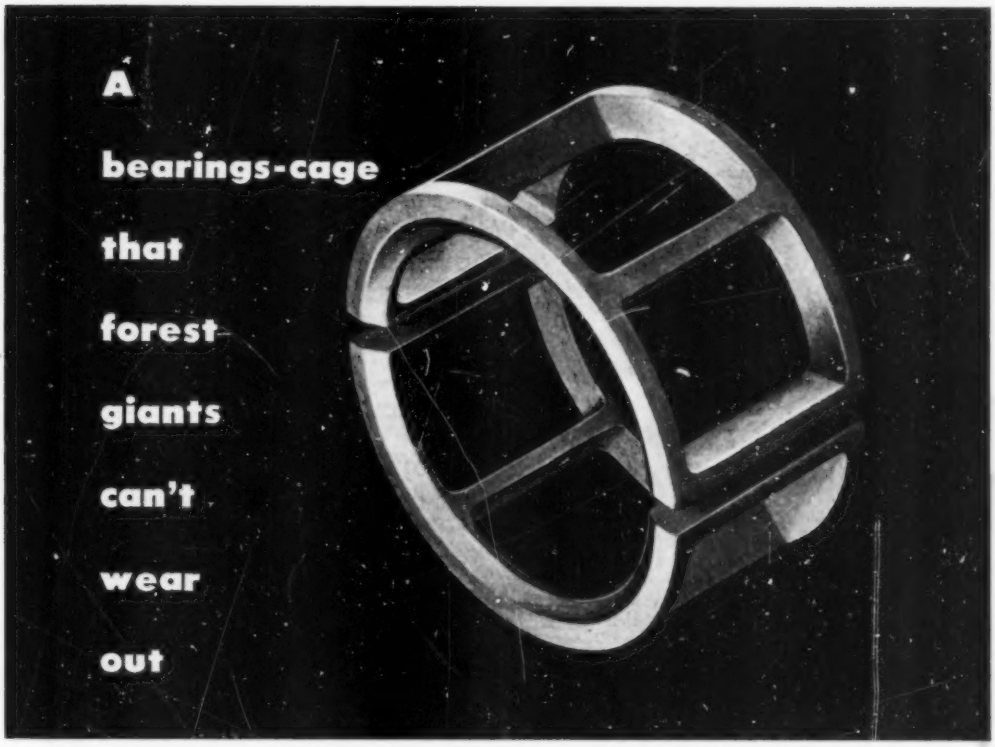

IT'S MADE OF BERYLCO BERYLLIUM COPPER

Ever see a giant fir felled by a chip-spitting mighty mite of a chain saw? All-weather production tools, chain saws have to be dependable, tough . . . and light. A lumberjack doesn't want to heft 100 pounds around all day if 50 will do the job.

McCulloch Motors shaved a pound off this figure in developing its two-man 5 hp saw and took full advantage of the unique properties of Berylco Beryllium Copper.

The roller bearing units which join connecting rod and crankshaft of this single-cylinder 2-cycle engine are held in place by two cage sections, each half holding nine rollers. The cage must withstand the punishing action of the rollers as well as the wear and thrust of the hardened steel crankshaft. Many materials were tested for this exacting application, but only Berylco could deliver the required combination of wear resistance, hardness and ductility.

The unique properties of this versatile alloy—its combination of great strength, electrical conductivity and resistance to corrosion—are as vital in the products of defense as they are in peacetime products. We invite you, in your plans for the future, to take advantage of the technical knowledge of the world's largest producer of beryllium copper.

Tomorrow's products are planned today —with Berylco Beryllium Copper.

Sample material available for testing purposes

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is available to you in our monthly technical bulletins. If you would like to be on the mailing list, simply write us on your business letterhead.

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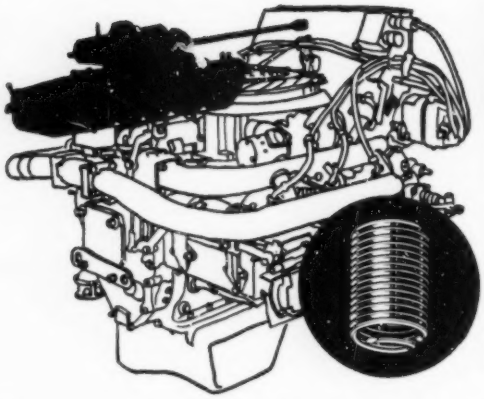

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Use Heli-Coil Inserts of precision-formed stainless steel or phosphor bronze wire. They give permanent armored protection to all threaded members. They ELIMINATE vibration-wear, failure and stripping . . . also galling, seizure, and corrosion, even in the presence of salt air, dampness and tropical humidity.

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Heli-Coil Inserts are widely used in jet and reciprocating engines – nearly 600 in one famous engine! – in airframes and accessories, in gun-mounts, radar and electronic instruments, fire-control mechanisms, transmissions and many other products. Heli-Coil Inserts fit National Coarse and Fine Thread sizes, pipe threads, all automotive and aviation spark plugs. Meet all industrial, military, and aircraft specifications. Class 2, 2B, and 3 fit.

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BALL JOINTS • PIPE PLUGS AND QUALITY SCREW MACHINE PRODUCT

Tourek's quality Ball Joints meet exacting requirements. Simplified design, improved performance, and lower costs result from specifying Tourek Ball Joints . . . the only recognized standard. Large stocks assure prompt delivery.

BALL JOINTS

Tourek's precision countersunk steel pipe plugs are accurate, high strength, and economical – resulting in the highest quality at prices which are competitive to old style plugs.

Stock sizes, available with National Pipe or Dry-Seal threads are: ¼", ⅜", ½", ¾" and 1". Also available on special order in alloy steels, aluminum or brass in sizes up to 2½" diameter.

PIPE PLUGS

Modern high speed single and 6-spindle automatics – together with complete secondary equipment, including grinding and brazing – plus 30 years' experience, assure you "The Best in Quality Screw Machine Products."

Your requirements, up to 2½", are made with utmost precision, and with prompt delivery assurances.

SCREW MACHINE PRODUCTS

LITERATURE

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CUTS
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There are two ways to make more money: cut your costs—increase your sales. American Flexible Metal Hose and Seamless Flexible Metal Tubing have cut many manufacturers' product costs by simplifying assembly; have made many products more useful and more salable.

SELLS
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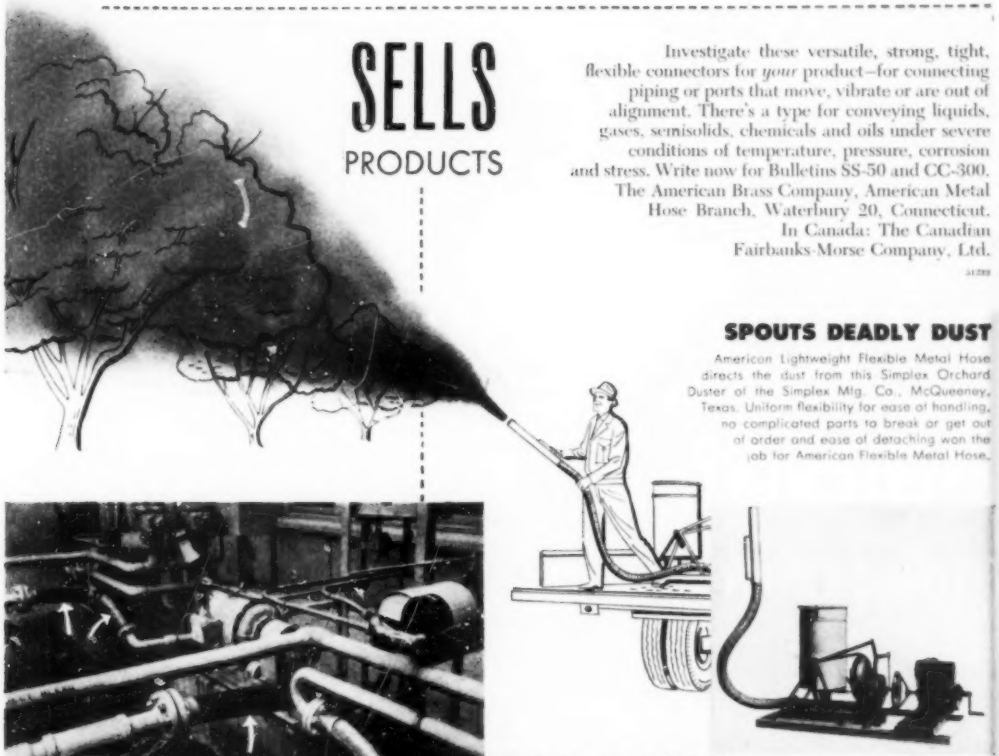
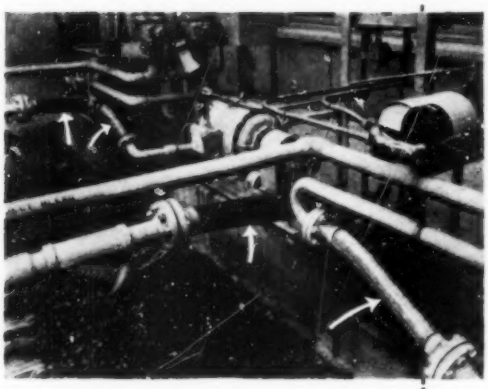
Investigate these versatile, strong, tight, flexible connectors for *your* product—for connecting piping or ports that move, vibrate or are out of alignment. There's a type for conveying liquids, gases, semisolids, chemicals and oils under severe conditions of temperature, pressure, corrosion and stress. Write now for Bulletins SS-50 and CC-300. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.



SPOUTS DEADLY DUST

American Lightweight Flexible Metal Hose directs the dust from this Simplex Orchard Duster of the Simplex Mfg. Co., McQueeney, Texas. Uniform flexibility for ease of handling, no complicated parts to break or get out of order and ease of detaching won the job for American Flexible Metal Hose.

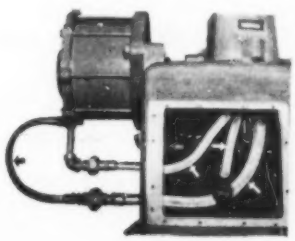


SOAKS UP SHOCKS

Four American Stainless Steel Flexible Tubing assemblies absorb shock from vaporization and hammer in suction and discharge of high-pressure pumps at Willow Island, W. Va., plant of American Cyanamid Co.

TIGHT SQUEEZE

American Seamless Flexible Bronze Tubing saves a lot of time and money in making the compressed air connections on this tube beading and flaring machine. Note flexible tubing's workability in confined spaces.



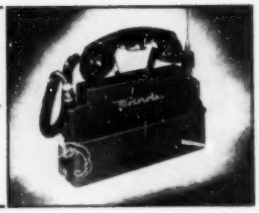
WHEREVER CONNECTORS MUST MOVE... *American*

ANACONDA

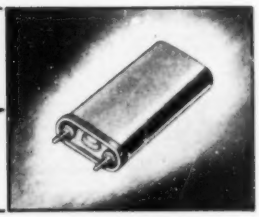
FLEXIBLE METAL HOSE AND TUBING

Supplying TODAY'S NEEDS and DESIGNING TOMORROW'S

JK CRYSTALS



Grand-daddy of this present-day Walkie-Talkie was one of the heroes of World War II. Now in civilian use, too, this pictured Motorola equipment uses James Knights H-17 crystals. Compactly dependable!



Tomorrow will probably unveil still another use for the refined JK H-17T. Doll-sized yet more precise than a jeweled watch movement, its 20-200 kc frequency range adapts perfectly to small equipment.

EVEN NOW JK CRYSTALS ARE GUARDING YOUR FUTURE

Because James Knights are tooled-up to manufacture every known existing crystal even as they are developing new designs for new uses, JK crystals are preferred in many critical defense projects. This very moment the Navy is putting several JK crystals through their paces in developing new hush-hush equipment. For the James Knights labs have the answer to any question crystal-wise.

Crystals FOR THE *Critical*

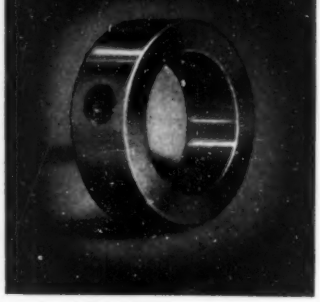
Critical tolerances and precision work have put James Knights UP FRONT. Their aim: to furnish every type crystal ever made, whether out-of-date, or still unheard of. To be sure, consult JK design engineers.

WRITE for free catalog, listing all JK crystals and specifications.

THE JAMES KNIGHTS CO.
SANDWICH 4, ILLINOIS

HALLOWELL

SOLID STEEL COLLARS
with
UNBRAKO
Self-Locking
HOLLOW SET SCREWS



Used Profitably...

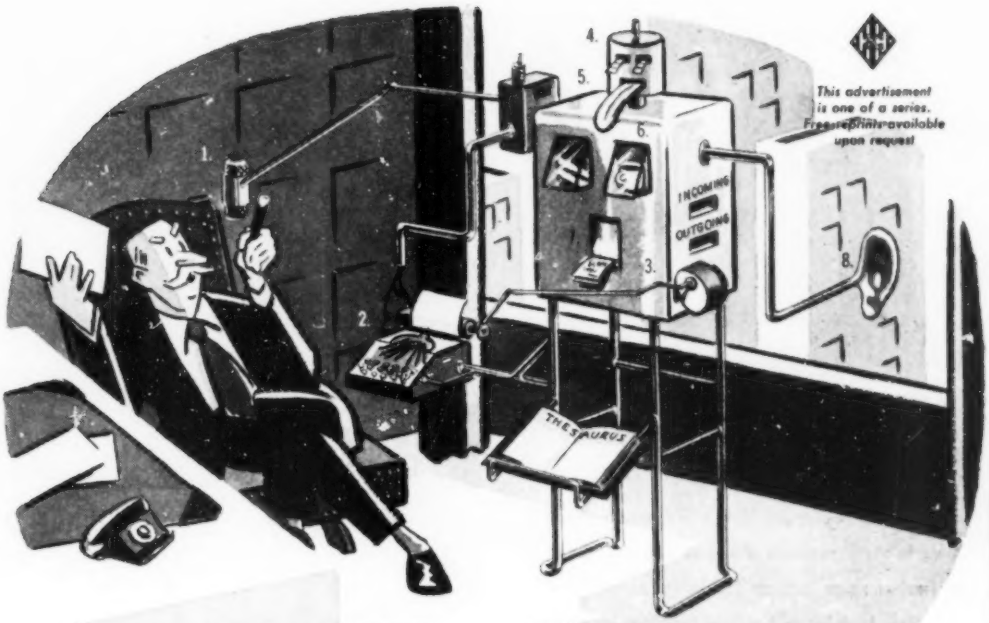
by manufacturers of such widely diversified products as *lawn mowers, food machinery, textile machinery, juke boxes, snow plows, conveyors, air compressors, agricultural machinery, electric fans, bottling machines,* and dozens of others.

Precision machined from solid bar stock in 42 stock sizes for shafts from 3/16" to 3" diameters inclusive.

Write for prices and name of your nearest distributor.

-SPS-

STANDARD PRESSED STEEL CO.
JENKINTOWN 28, PENNSYLVANIA



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1. Microphone carries voice into typewriter.
2. Self-operating typewriter puts dictation on paper.
3. Motion of typewriter carriage operates pencil sharpener.
4. Postage dispenser supplies stamps.
5. Mechanical tongue moistens stamps.
6. Automat provides quick lunch.
7. Date pad reminds executive of appointments.
8. Giant ear picks up and records all office gossip.

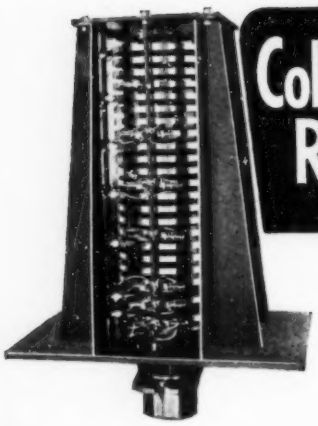
There once was a man named Oddfellow
Who picked us to make parts for this steno
'Cause he wanted quality, good service and all
We said, "Sir, we're delighted
But please don't feel slighted
If top-rated jobs get first call."

H & H makes brass or copper tubing ranging from ⅛" O.D. to and including 1½" O.D. Also brass and copper LOCKSEAM tubing for aircraft, jeep, truck and stationary engine cooling components.

Since nothing will ever take the place of a woman, you will probably never need parts for a machine quite like this. Yet, no matter what your needs may be, it will pay you to think of H & H, especially in connection with hard-to-fabricate tubular parts. When tolerances must be held to strict Army-Navy specifications, no one is better qualified or more experienced than we. So always remember, no matter what you buy or manufacture, no matter how exacting your requirements may be, you can look to H & H for quality, service—and savings too. Our facilities for CMP rated jobs are at your disposal. Why not write, wire or call us today?

H&H TUBE AND MANUFACTURING COMPANY
275 North Forman Avenue, Detroit 17
Originators and sole makers of "Metalfs"—the economy tubing

H & H MEANS QUALITY AND SERVICE IN BRASS AND COPPER TUBING



Collector Rings

WELCO Collector Rings are made in all sizes to carry currents of 5 to 200 amperes. Two to twelve rings can be furnished on one stub complete with brush holders, brushes, studs for supporting the brush holders and stud rings. The collector rings can be assembled as a unit on one hollow tube with threads on one end and insulation bushing on the opposite end. The brush holders carrying the current are made of brass. The collector rings are made of hard bronze material. Bakelite insulation is used.

Welco Collector Rings are custom-built to fit the special design and functional requirements of your machines or equipment. A limited number of standard types are available. Send us your blueprints and we will design for you the collector rings that are functionally correct.

THE B. A. WESCHE ELECTRIC CO.
1624-20 VINE ST. CINCINNATI 10, OHIO

End of the line

Permanent magnets inside pulley cause tramp metal to cling to belt as coal feeds by and drops off. After belt passes underside of magnetized pulley, tramp metal drops into separate bin.

for tramp metal

Metallic scrap in coal has long played serious havoc in furnace machinery—industrial or home. But, thanks to this new Homer Permanent Magnet Separator Pulley for coal conveyors, all harmful tramp metal can now be removed while loading for shipment.

Here, as in so much of industry's hard working equipment, you'll find Shafer ConCaVex Pillow Blocks on the job . . . minimizing friction, reducing power consumption, compensating for misalignments, providing reserve load and shock capacities and protection against the ravages of extreme weather, dust and dirt conditions that are part-and-parcel of coal processing operations.

Shafer ConCaVex bearing units (famous for a third of a century) are available in a full range of types and sizes that cover hundreds of industrial requirements—and probably yours. Write for Industrial Bearing Catalog No. 51.

Aircraft Bearings, Too!
Single row, double row, rod end types—for all control mechanisms—for all types of air-borne craft. Write for Aircraft Bearing Catalog No. 50

SHAFER CONCAVEX

SHAFER BEARING CORPORATION
801 BURLINGTON AVE.
DOWNERS GROVE, ILLINOIS

It's time we got *working* mad!

As we listen to the latest insults from Moscow, we're likely to get fighting mad.

Instead, we'd better use our heads and get *working* mad.

It is clear by now that Stalin and his gang respect just one thing—strength. Behind the Iron Curtain they've been building a huge fighting machine while we were reducing ours. Now we must rebuild our defenses—*fast*.

As things stand today, there is just *one* way to prevent World War III. That is to re-arm—to become strong—and to stay that way!

This calls for better productivity all along the line. Not just in making guns, tanks and planes, but in turning out civilian goods, too.

Arms must come first. But we must produce arms *at the same time* we produce civilian goods.

We can do this double job if we all work together to turn out more for every hour we work—if we use our ingenuity to step up productivity.

All of us must now make sacrifices for the common good. But we're working for the biggest reward of all —*peace with freedom!*

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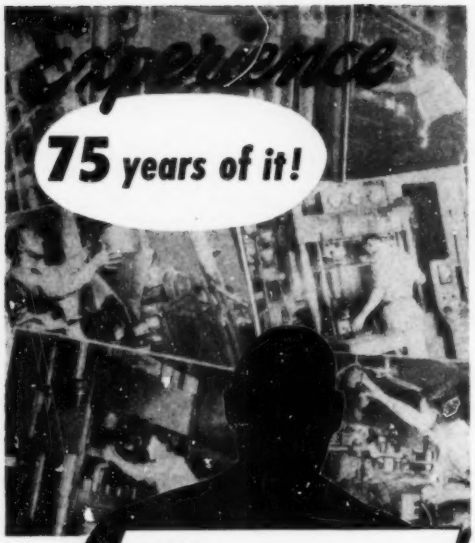

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What does this experience mean to you as a buyer of molded plastics? It is your assurance that the final design is sound . . . that the mold is engineered and built by experts . . . that the molding is done by the best methods and equipment. AUBURN molds all plastic materials and is completely unbiased as to type or method. Finally, it marks AUBURN as a reliable subcontractor

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Auburn salesmen are Sales Engineers—not agents—available for consultation with your design engineers. Or, if your design is complete, send us prints for quotations—without obligation.

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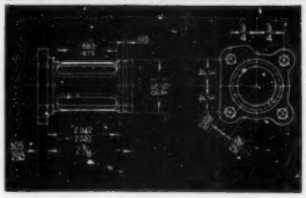
350 McMaster Street, Auburn, New York
Founded in 1876 Telephone 3-5320

MISCO *Precision* CARBON AND STAINLESS STEEL **CASTINGS**
CAST TO MICROMETER TOLERANCES



Part:
AIRCRAFT CARBURETOR METERING VALVE
Alloy: Misco 18-8 (A.M.S. 5640)
Weight: 7.06 oz.

Misco Precision Castings make possible quantity production of pieces such as this which would be costly to attain by usual machining methods.

Types of parts which can be processed at a saving by the Misco Precision Casting Process cover a wide range. The Misco Precision Cast stainless steel aircraft part shown weighs 7.06 ounces as cast. Produced to the most rigid aircraft material specifications this piece was formerly machined from bar stock weighing three pounds. Here is a saving of 84% in weight of scarce metal alone and a more considerable economy in machining time. Castings of intricate design, close tolerances, with radiographic and metallurgical control, are obtainable from Misco in alloys ranging from carbon steels and stainless steels to non-forgeable super-alloys for use in high temperature jet aircraft applications. Misco, a pioneer producer, offers extensive technical experience in design, production and application of small precision cast alloy steel parts.

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SKINNER STAINLESS STEEL
SOLENOID VALVES
Small size — Rugged — Large capacity

The small size of Skinner Solenoid Valves belies their rugged construction and unusually large capacity. These valves have a standard range from 5 to 250 p.s.i., and a special range from 5 to 850 p.s.i., and can be used for gaseous or liquid media. Their soft insert seat prevents leakage and positive action is assured by spring loading. Skinner Valves may be used in any position, with pipe connections furnished to suit specifications. Power consumption is 10 watts max. Special coils for high humidity or high temperature applications can be supplied. Standard models are approved by Underwriters' Laboratories.

Write for Bulletin No. 501

SKINNER ELECTRIC VALVES
SKINNER ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
132 Belden Ave., Norwalk, Conn.

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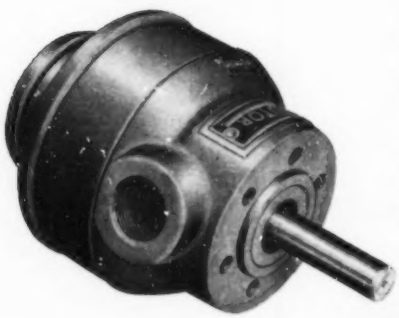
. . . and install GEROTOR

hydraulic pumps

for improved performance



*Punch presses . . . baling presses . . . straightening presses . . . piercing presses . . . assembly presses . . . plastic presses . . . *any* hydraulically operated presses work better with GEROTOR Hydraulic Pumps. Whether you build them or maintain them, specify GEROTOR Pumps . . . for pressures up to 1200 p.s.i. continuous, 1500 intermittent . . . deliveries from .4 to 40 g.p.m.

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Our equipment and facilities coupled with the individual skills of New England craftsmen enable us to fill orders for any type of gear in any quantity, any size and any material—metallic or non-metallic.

Have us quote on your requirements.

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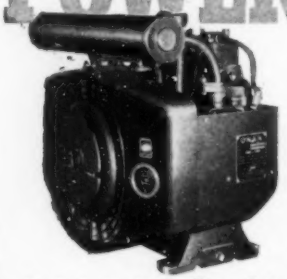
Ground Thread Worms

PERKINS MACHINE & GEAR COMPANY

WEST SPRINGFIELD, MASSACHUSETTS

Smooth POWER



ONAN *Twin-Cylinder 4-cycle*

"CK" ENGINES

The smooth-flowing power of the Onan "CK" horizontal-opposed, twin-cylinder, alternate-firing engine will give superior performance to your engine-driven equipment. Vibration-free operation, lightweight aluminim construction (it weighs only 97 pounds), and heavy-duty characteristics give the 10 HP "CK" the qualifications you've been looking for in a rugged prime mover. 4-cycle air-cooled. Electric or manual *instant* starting.

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Onan

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after you've read this magazine

. . . and clipped pertinent ideas, articles and advertisements for reference, *please do not burn or throw it away.*

Here are two sound reasons why:

1) Wastepaper can help to swell the funds of your local Boy Scout Troop, your church or other community organization. It gets a good price these days.

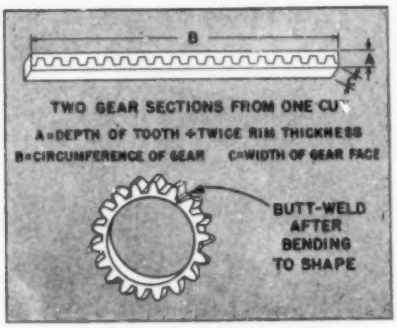
2) Whether in magazine form or not, wastepaper helps to fill the increasing need for paper pulp brought on by the mobilization effort.

Collect it. Give it to your favorite organization. Chances are they have scheduled pick-ups.

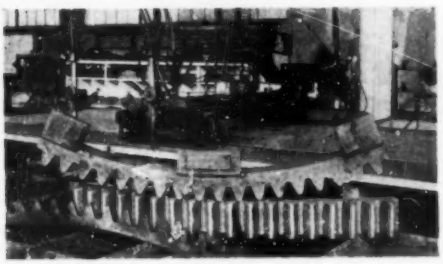
Ideas on Welded Design—For the Engineer's Notebook

DON'T OVERDESIGN

Careful consideration of allowable tolerances often results in reduced costs through elimination of overdesigned parts. Precision gears, for example, are an unwarranted expense where more economical gears that are accurate within 1/64 inch will give just as satisfactory service.



Such gears, for farm machinery, cement mixers, and similar equipment are produced by oxygen-cutting and welding as shown in the sketch. One cut makes two gear sections. There is no scrap loss. Welded circular sections require further finishing only in weld areas.



Eight steel sections like this, oxygen-cut from 5-in. thick slabs, are welded together to make 14-ft. diameter gears for pontoon cranes. Maximum tolerance is only 1/32 in., but no machining is required.

For further information about oxygen-cutting, welding and other cost reducing LINDE methods, phone or write LINDE AIR PRODUCTS COMPANY, a Division of Union Carbide and Carbon Corporation, 30 East 42nd Street, New York 17, N.Y. Offices in Other Principal Cities. In Canada: Dominion Oxygen Company, Limited, Toronto.

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Please send me my free copy of 20-page booklet, F-7811, entitled "Improved Design for Welding."

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was this call necessary?

Some "Moral Insurance" here might have avoided a serious accident

Workmen's compensation is a fine thing—but it can't replace a mangled arm.

Safety laws prevent many accidents—but they can't cover every hazard of an individual plant.

Accident prevention which goes *beyond the law* is an unwritten responsibility of every employer. It is his "Moral Insurance" for his employees welfare.

The premiums for "Moral Insurance" are not high. They do not have to be paid for in fancy safety gadgets. Their cost is simply the institution of common sense safety regulations covering all local hazards—enforced by employee committees with the full support of management.

Yes—"plant safety" is a mutual job.

DON'T FORGET—THE LIFE YOU SAVE MAY BE YOUR OWN

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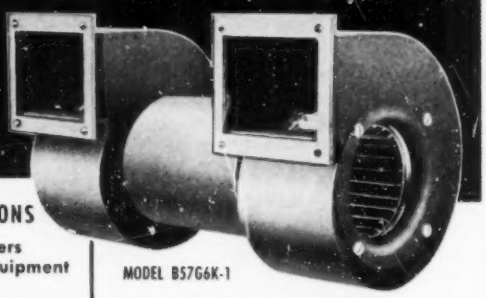

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APPLICATIONS

- Transmitters
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- Amplifier Equipment
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MODEL B57G6K-1: 115 volt AC • 60 cycle • single phase • 4 mfd. • 120 CFM at 0.5" SP—220 CFM at 0" SP • Silicon impregnated • Fungus proof.

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DESIGN ENGINEERS

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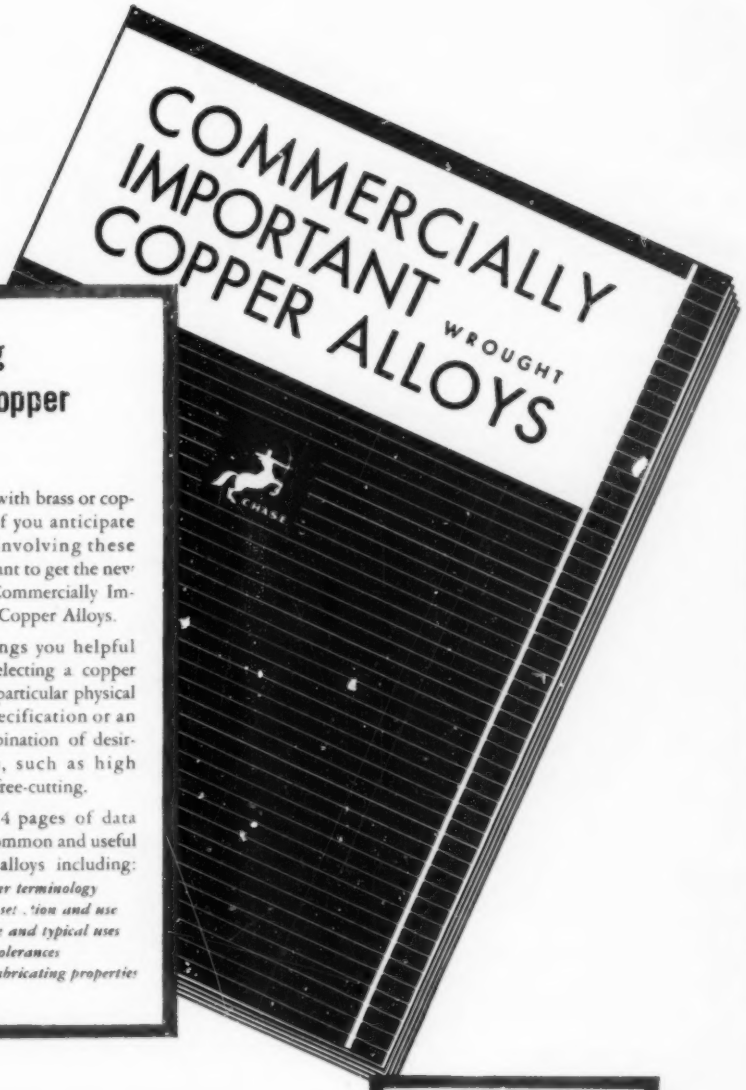
They—and their assistants—are the readers of this magazine. You can hire them by placing a "position vacant" advertisement where they are sure to see it—in our classified section starting on page 429.

PRODUCT ENGINEERING

To tap this manpower market, just send in your advertisement before March 16 directly to us at 330 W. 42nd St., N. Y. 18, N. Y.



Fabricating brass or copper alloys?

If you're working with brass or copper alloys . . . or if you anticipate defense orders involving these metals . . . you'll want to get the new Chase book on Commercially Important Wrought Copper Alloys.

This book brings you helpful suggestions for selecting a copper alloy to meet any particular physical or fabrication specification or an alloy with a combination of desirable properties, such as high conductivity and free-cutting.

It contains 124 pages of data about the more common and useful wrought copper alloys including:

- *brass and copper terminology*
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Because Bush spacing fingers are interlocked to insure permanent coil rigidity which guarantees long life and minimum service.

Bush Finned Tubing is available in aluminum, steel and copper in a full range of sizes and spacings. For complete information address Bush Manufacturing Company, West Hartford 10, Connecticut.

Buy the Best-and the Best is

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Type "E" Pressure Reducing and Regulating Valve

You'll find CASH-ACME Automatic Valves on the job in the giant meat industry. The sausage stuffer shown at right is just one application of many where a CASH-ACME Valve is giving dependable pressure control. If you have the problem of finding a lifetime valve that will turn in consistent performance year after year on the products you manufacture, write today. We can show you the installation that will do the job.

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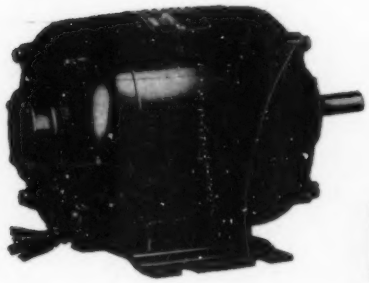
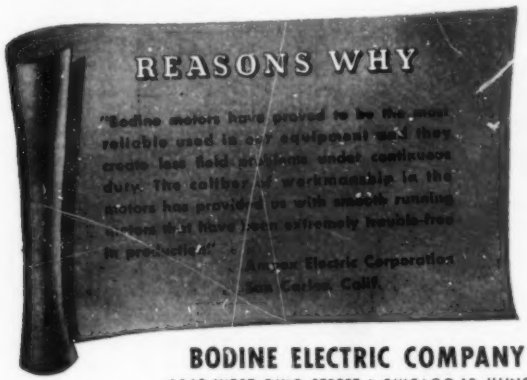


Award Winning Tape Recorder uses BODINE MOTORS

In the 12th Annual Product Design Competition, conducted by Electrical Manufacturing Magazine, the compact Ampex High Fidelity Professional Tape Recorder was presented with one of the five awards for excellence of design. This brings the total of award winning products using Bodine Motors, for the years 1948, 1949 and 1950, to four.

Of more interest to users of small motors is the fact that all of the award winning products, for these three years, that were powered by fractional horsepower motors within the size range (1/2000 to 1/6 H.P.) offered by Bodine...used Bodine Motors!

The reputation of Bodine Motors for quality and service is based on nearly a half a century of experience and protected by numerous production tests...thorough final assembly tests...finest possible materials. .skilled, experienced workers. If you have a fractional horsepower motor application problem, it will pay you to consult Bodine Engineers.


REASONS WHY
"Bodine motors have proved to be the most reliable used in our equipment as they create less field questions under continuous duty. The caliber of workmanship in the motors has provided us with smooth running ... as it have been extremely trouble-free in production."
Ampex Electric Corporation
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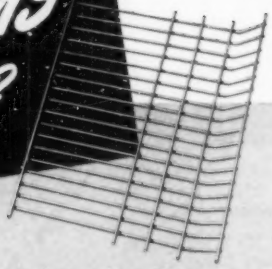
Any of these PROBLEMS Like Yours?



Had to Conserve Steel

Ice deflector assembly made by Company A for ice cube machines consisted of sheet steel, woven wire cloth and steel frame. Material shortages loomed. Told it to Titchener. Titchener designed this welded wire rack using one size of wire. Now assembly proved to be sturdier — rustless — lower in cost. Additional dividends: simple tooling — fast large-scale production.

Note: Wire is more readily available during shortages. Can your product be made of wire? Ask Titchener.

Wanted Substitute for Casting

Company B, a stove manufacturer, was dissatisfied with breakage of its cast iron burner grates. Told it to Titchener. This Titchener welded-wire assembly was substituted. Result: No breakage — costs less.

Note: Wire is rigid, yet resilient. Light, yet tough. Stronger than castings or forgings. Wondering if wire can help you? Ask Titchener.

Design Was Difficult to Produce

Company C designed this complicated two-piece floor mop wire clamp. Ran into production difficulties. Told it to Titchener. Our skilled tool makers developed an ingenious method of coiling wire around itself. This made it possible to produce thousands of precision-made clamps at high speed on Titchener's forming machines.

Note: Titchener has worked hand in glove with all types of industry — large and small — in peace and war — for 65 years. How can Titchener serve you?

Tell it to TITCHENER!

If your problem involves wire forms, light stampings, welded-wire assemblies or wire-and-strip-steel items — Tell it to Titchener.

Titchener offers you . . .

- Design Assistance
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- High Volume Production
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- Sample Making
- Quickly Available Materials
- Careful Inspection
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Send us your prints — or describe your problem in a letter. Confidential. No charge for our suggestions.

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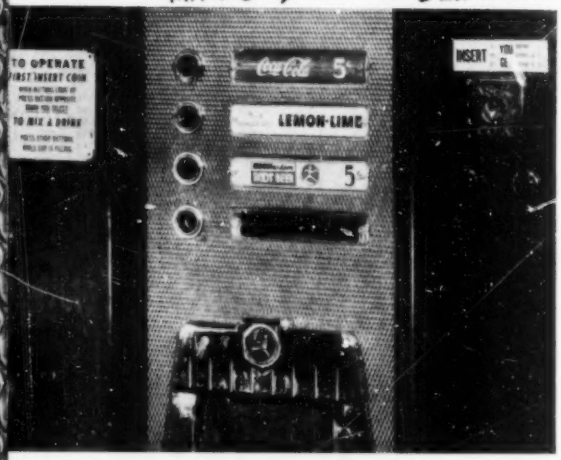

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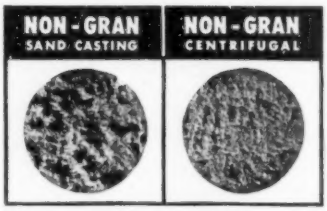

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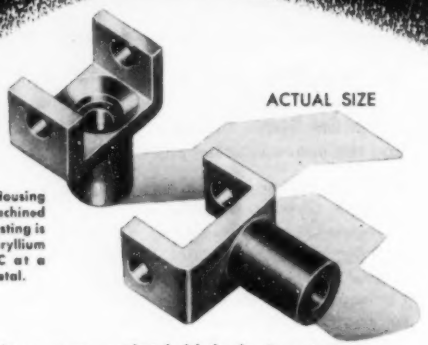

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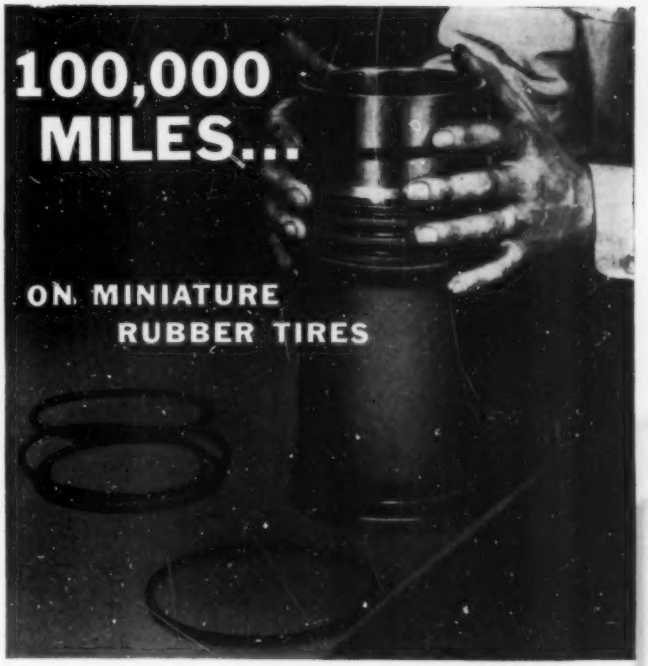

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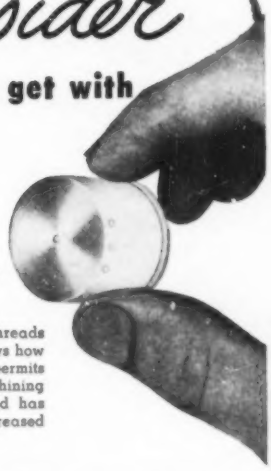

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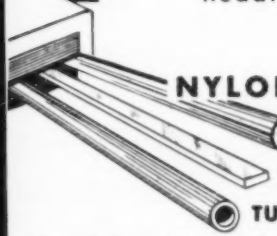

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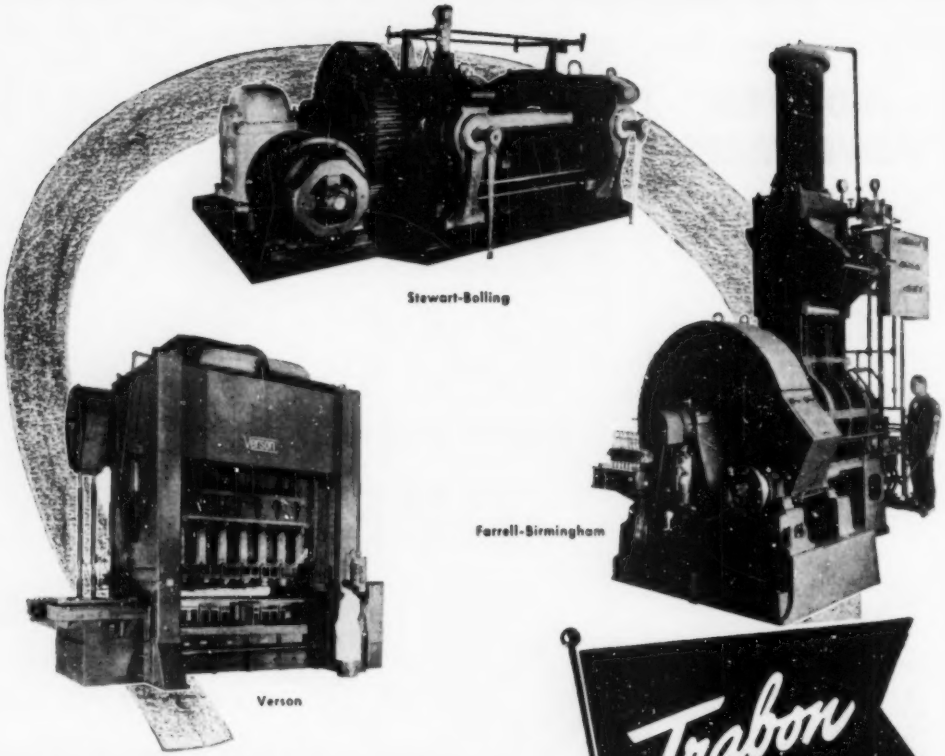

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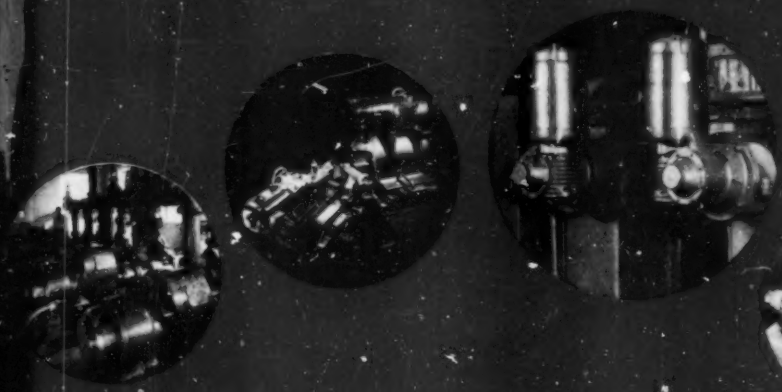

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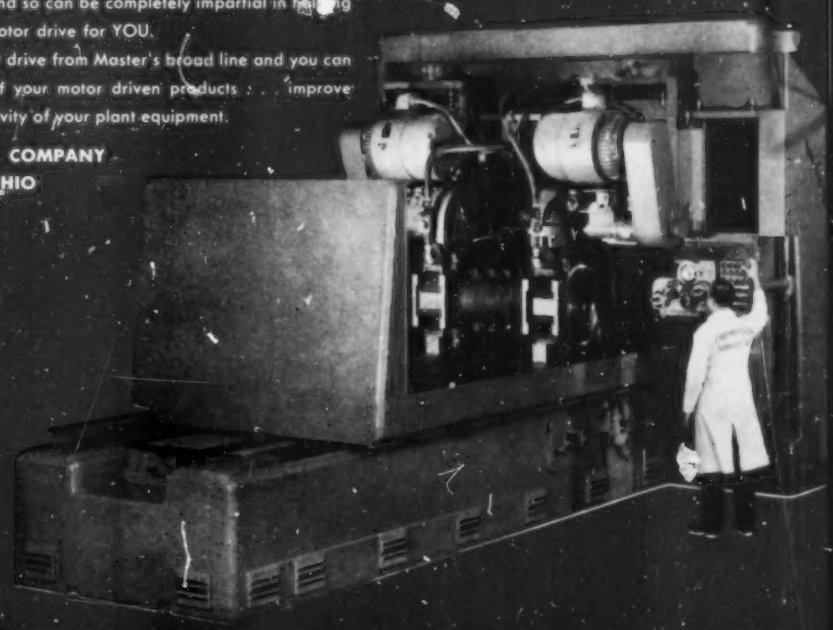

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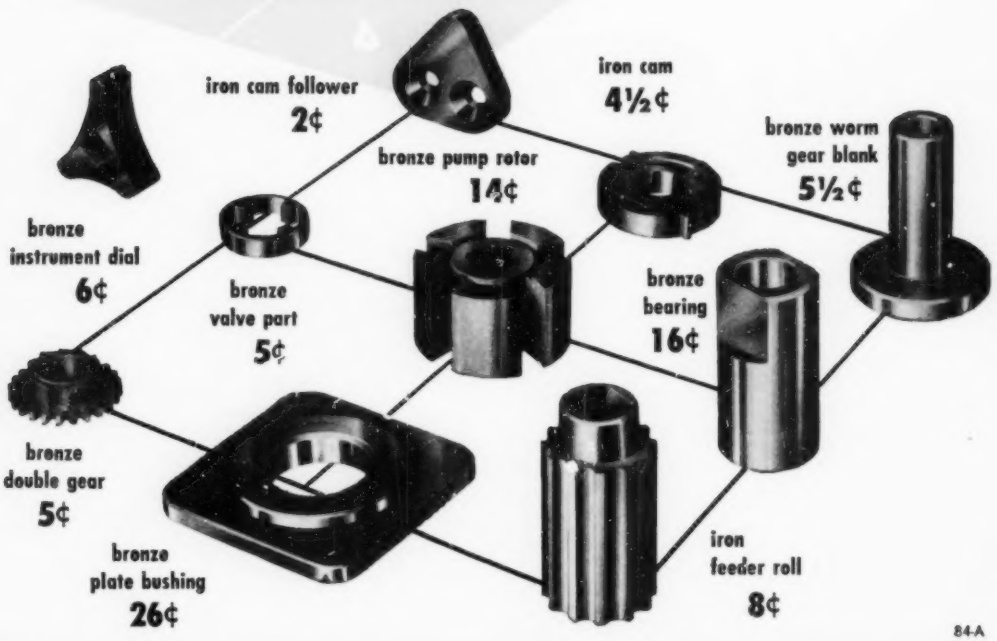

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